FINAL

INDUSTRIAL WAREHOUSING

IN THE SCAG REGION

TASK 4. Understanding Facility Operations

APRIL 2018

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technical memorandum

Southern California Association of Governments Industrial Warehousing Study

Task 4. Understanding Facility Operations

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Executive Summary

Task Goals and Outputs

This technical memorandum describes the primary work conducted under Task 4, which consisted of:

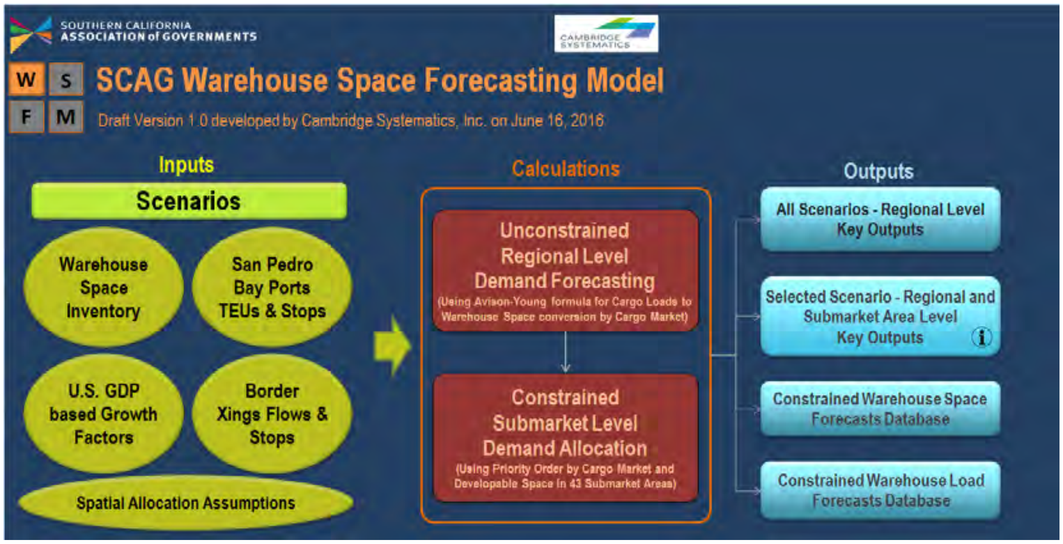
- Researching facility operations to be able to describe their most important features and how that impacts supply of and demand for warehouse space in the Southern California Association of Governments (SCAG) region. These qualities can be expressed in terms of:
  - Characteristics that affect public costs (i.e., building size, cargo turnover rate, neighborhood land uses, road congestion, and access to highways/rail);
  - Characteristics that affect facility operator costs (i.e., building age, building size and layout, number of loading docks/doors, cargo turnover rate, labor productivity, and automation); and
  - Characteristics that affect user costs (i.e., proximity to ports for port-related cargo, proximity to customers for distribution centers, lease rates, truck and container parking availability, labor availability and productivity, and equipment and information technology (IT) systems automation).
- Creating and refining the classification of facility types, based upon their physical and operational characteristics, in order to narrow down and select the most relevant for the warehouse supply and demand model. This categorization will inform the scenario planning and policy work in Task 5.
  - Classification is useful to public planning and policy-making since it demonstrates the varying needs and solutions for port-related warehouse users and distribution center users, as well as different levels of conflict with the public by location (city), size of facility (square footage), and scale of operations (cargo turnover rate); and
  - A hierarchical classification was adopted for warehouse space modeling, composed of five port-related cargo submarkets and three nonport--related cargo submarkets.
- Developing the methodology to update and improve the existing warehouse supply and demand model and the 2014 and 2040 baseline scenario, which will be used in the scenario planning work in Task 5.

Methodology

- Prepared a comprehensive warehouse space inventory using a detailed warehouse facility location and type data in the form of 2014 CoStar Property® data, and using a detailed parcel-level land uses data in the form of 2012 SCAG existing land use and 2012 SCAG general land use plan data.

- Developed a logical and robust warehouse space forecasting model by combining various cargo forecasts, including port-related and border-crossing related, and predicting overall cargo forecasts using a socioeconomic variable of U.S. GDP.

Figure ES.1 Overview Diagram of SCAG Warehouse Space Forecasting Model



- Significantly expanded functional uses of warehouse space and cargo markets utilizing warehouses that can be analyzed using the warehouse space forecasting model. The model covers the functional uses of port-related crossdock transloading, border-related transloading, small distribution center, mega-distribution center, retail fulfillment centers, and general purpose warehousing. In addition to port-related and domestic cargo markets, the model now covers border-crossing-related cargo market.
- Customized and parameterized region-level warehouse space forecasting using Avison-Young formula by cargo submarket type and spatial allocation assumption of region-level forecast to submarket areas by cargo submarket type.
- Added scenario-specific inputs and parameters and calculations within the warehouse space forecasting model in order to analyze alternate policy scenarios.
- Enhanced visualization of warehouse space forecasting model outputs to easily identify supply and demand issues across geographical and temporal scales, cargo submarket types and alternate policy scenarios.

Potential Uses of the Model

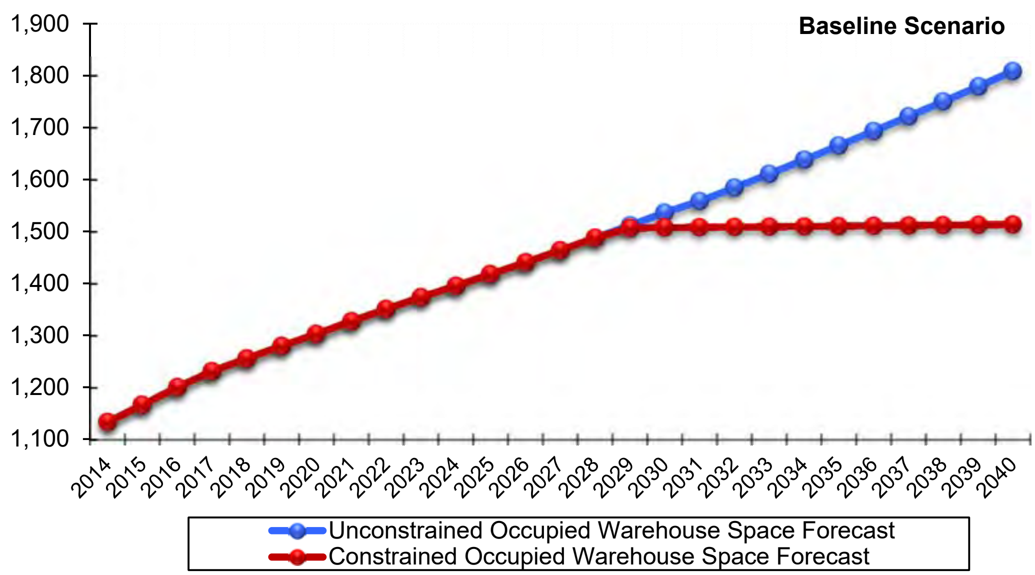
- Identifying the potential disparity between warehousing supply and demand;
- Identifying which submarket areas are projected to have a shortage of warehousing supply and coordinating with jurisdictions to address these shortages;

- Understanding user requirements (i.e., how much square footage of warehouse space would be needed and by when); and
- Providing revised inputs to the regional travel demand model to evaluate transportation system performance.

Key Findings of Baseline Scenario

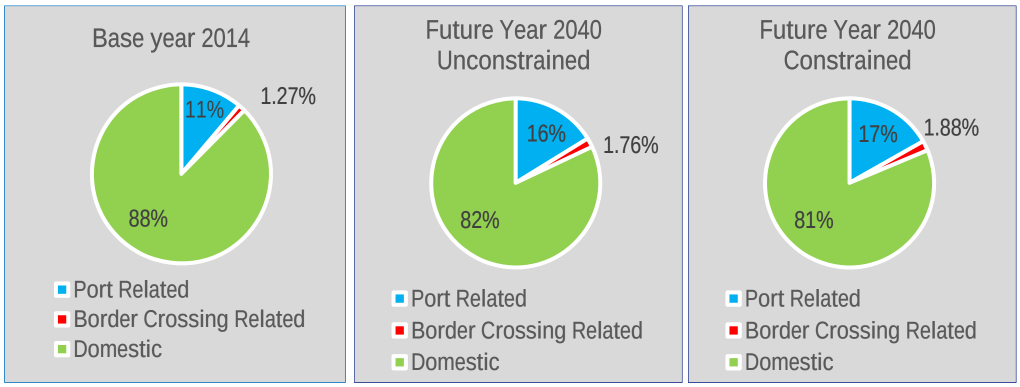
- Features of baseline scenario: uses baseline forecasts for port- and border-crossing-related cargo, no cargo storage efficiency gains across time, no replacement of obsolete buildings, warehouse space functional use mix not changing across time, existing estimated developable space; and
- Identified supply shortfall – starting in 2029, expected to reach 295 million square feet by 2040

Figure ES.2 Unconstrained versus Constrained Regional-Level Total Occupied Warehouse Space Forecasts by Year in the SCAG Region, *2014 to 2040 (Millions of Square Feet)*



- Identified cargo market mix changes – port- and border-crossing-related shares increasing, while domestic decreasing; domestic still to remain dominant

Figure ES.3 Regional-Level Occupied Warehouse Space by Cargo Market Type, 2014 versus 2040 Unconstrained versus 2040 Constrained



- Compared cargo submarket unconstrained growth and constrained growth and verified no functional use mix changes – constrained port and domestic growth is lower than unconstrained growth; percent Regional Distribution Center (RDC) to remain around 22 percent.

Table ES.1 Regional-Level Occupied Warehouse Space by Cargo Submarket Type, 2014 versus 2040 Unconstrained versus 2040 Constrained

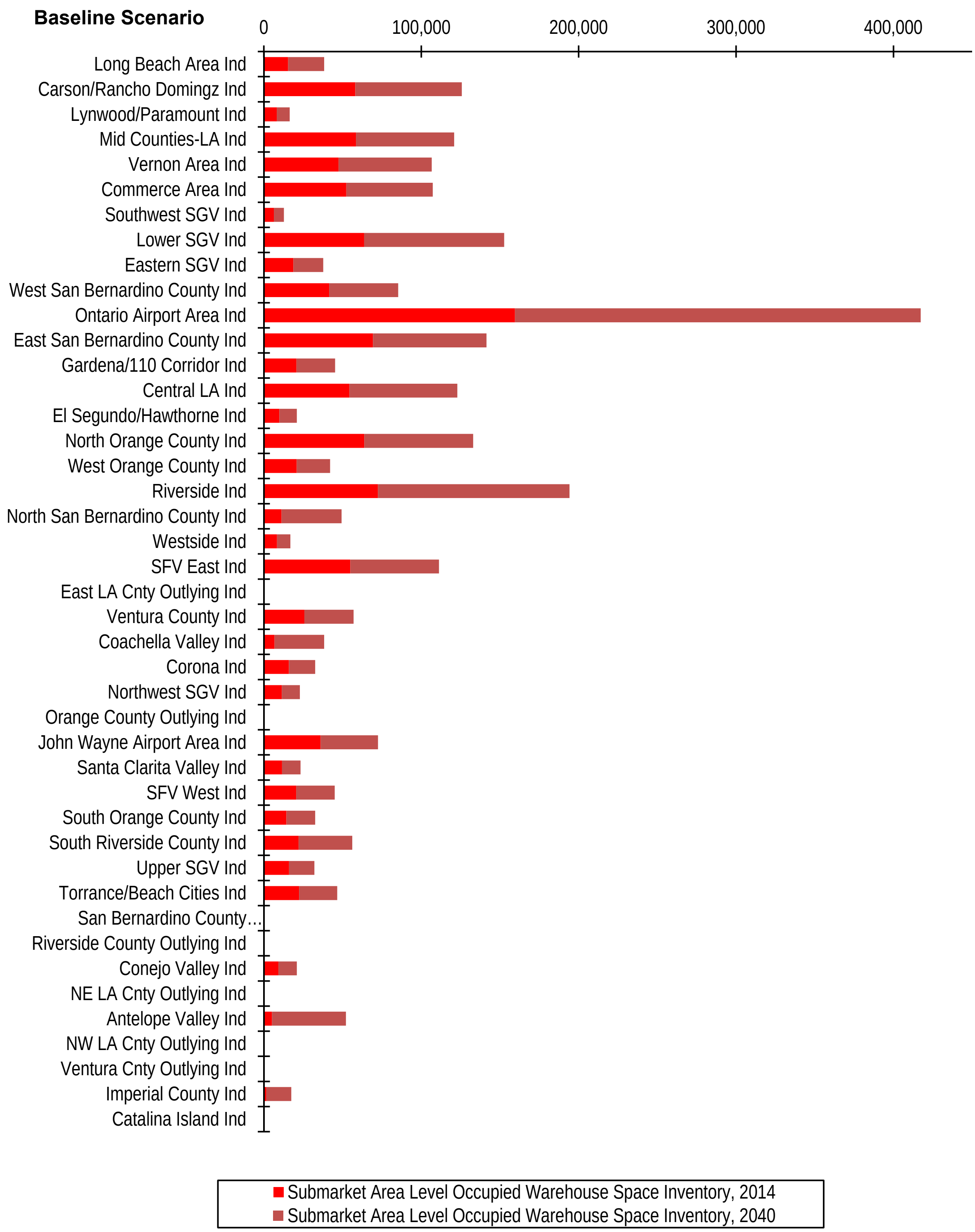
Cargo Market	Cargo Submarket	2014 Warehouse Space (Millions of Square Feet)	2040 Unconstrained Warehouse Space (Millions of Square Feet)	Percentage Change, 2014-2040	Equivalent CAGR, 2014-2040	2040 Constrained Warehouse Space (Millions of Square Feet)	Percentage Change, 2014-2040	Equivalent CAGR, 2014-2040
Port Related		126.6	259.1	105%	2.8%	240.3	90%	2.5%
1	Ports Import Loads to Crossdock Transload Facilities	4.0	9.0	124%	3.2%	8.0	99%	2.7%
2	Ports Import Loads to Small RDCs (<500,000 SF)	16.2	30.1	86%	2.4%	28.2	74%	2.2%
3	Ports Import Loads to Mega RDCs (>=500,000 SF)	11.7	21.7	86%	2.4%	20.3	74%	2.1%
4	Ports Import Loads to Import Warehouses	81.8	183.6	124%	3.2%	170.1	108%	2.9%
5	Ports Export Loads to Export Warehouses	12.8	14.7	14%	0.5%	13.7	7%	0.3%
Border-Crossing Related		14.4	31.8	121%	3.1%	31.8	121%	3.1%
6	Border-Crossing Import Loads to Crossdock Transload Facilities in Imperial County	0.1	0.3	148%	3.6%	0.3	148%	3.6%
7	Border-Crossing Import Loads to Small RDCs (<500,000 SF)	0.8	1.6	115%	3.0%	1.6	115%	3.0%
8	Border-Crossing Import Loads to Mega RDCs (>=500,000 SF)	0.5	1.2	115%	3.0%	1.2	115%	3.0%
9	Border-Crossing Import Loads to Import Warehouses (Excl. Exports via Ports)	6.5	14.7	126%	3.2%	14.7	126%	3.2%
10	Border-Crossing Export Loads to Export Warehouses (Excl. Imports via Ports)	6.5	14.0	116%	3.0%	14.0	116%	3.0%

Cargo Market	Cargo Submarket	2014 Warehouse Space (Millions of Square Feet)	2040 Unconstrained Warehouse Space (Millions of Square Feet)	Percentage Change, 2014-2040	Equivalent CAGR, 2014-2040	2040 Constrained Warehouse Space (Millions of Square Feet)	Percentage Change, 2014-2040	Equivalent CAGR, 2014-2040
Domestic		993.5	1,518.2	53%	1.6%	1,241.9	25%	0.9%
11	Domestic Loads to Small RDCs (<500,000 SF)	129.5	209.7	62%	1.9%	178.1	38%	1.2%
12	Domestic Loads to Mega RDCs (>= 500,000 SF)	93.2	150.9	62%	1.9%	127.1	36%	1.2%
13	Domestic Loads to General Purpose Warehouses	770.8	1,157.7	50%	1.6%	936.7	22%	0.8%
Total		1,134.4	1,809.1	59%	1.8%	1,514.1	33%	1.1%

CAGR – Calculate Compounded Annual Growth Rate.

- The constraint due to lack of further developable warehouse space could result in added pressure on warehouse operators for higher cargo turnover rates, and beneficial cargo owners (BCO) on faster product sales. It is, therefore, logical to expect greater "pull" logistics than "push" logistics, and the SCAG region may have the ability to absorb some of the unmet demand.
- However, there are practical limits in terms of the warehouse operational capacities and year-to-year growth in sales volume of BCO. In addition, the rental costs for warehouse space in the SCAG region, could rise dramatically under a warehouse space shortage situation. Competition from other regions including Savannah and Charleston, in the U.S. with sufficient land supply and compelling economics, also could serve the unmet demand.
- Identified top growth submarket areas and provided as input to travel demand model.

Figure ES.4 Submarket Area-Level Occupied Warehouse Space, 2014 versus 2040 Constrained
Thousands of Square Feet



1.0 Facility Operations

Industrial warehouses vary in their physical, operational and inventory characteristics. Factors that influence the configuration and characteristics of a distribution center depend upon the BCO's business profile, as well as the requirements of the 3PL's BCO customers.

Physical characteristics important for this study include:

- Building area;
- Floor area ratio;[1]
- Ceiling height;
- Number of loading docks;
- Size of office space;
- Number of truck and container parking spaces in the yard; and
- Interior layout and configuration of storage space (i.e., number of storage lanes, width of aisles, and cargo rack height) and cargo unloading and loading dock space.

Physical characteristics inside the building determine the "theoretical storage capacity" for a warehouse, which can typically range between 22 to 27 percent of the building's cubic capacity.[2] Generally, multitenant and shorter buildings have a lower percentage of cubic space dedicated to storage because of fixed minimum office space and vertical clearance space requirements.

Utilization of the warehouse theoretical storage capacity, or "working storage capacity," generally ranges between 60 to 90 percent of the theoretical storage capacity.[3] It is dependent on operational characteristics, including labor productivity, IT systems in place, use of automated equipment (i.e., automated cargo put away and retrieval systems, item and carton sortation systems, robotics, guidance systems, man-up turret trucks,[4] etc.), and the way storage space is arranged. Generally, when the cost per unit storage space is high or the labor to handle the storage and retrieval activities is relatively less expensive, or these activities are highly automated, a warehouse has a greater amount of rack storage space than floor type storage, as well as narrower aisle spaces. This results in a higher percentage utilization of available cubic storage space.

"Working throughput" is the total cargo that enters or leaves a warehouse facility in a year. The conversion factor between the working storage capacity and working throughput is called the cargo turnaround time (or days cargo remains in inventory). Cargo turnaround

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[1] Floor area ratio is the ratio of building area to land or site area in which the building is located.

[2] http://www.warehousecoach.com/images/Storage_Space_Utilization.pdf (last accessed on June 1, 2016).

[3] http://www.inventoryops.com/articles/warehouse_capacity.htm (last accessed on June 1, 2016).

[4] http://www.inventoryops.com/Aisle%20Width.htm (last accessed on June 1, 2016).

times can vary widely, ranging from one day to several months in a year, and is dependent on the inventory characteristics, such as the following:

- Cost of entire inventory and costs of individual Stock Keeping Units (SKU);
- Demand for the product;
- Nature of the product; and
- Functional use type of facility.

Sometimes, the physical characteristics outside the building, such as the number of loading docks, and container/trailer/truck parking spaces, etc., and management of operations, can constrain the cargo turnaround times, thereby, lowering the warehouse working throughput.

Inventory turnover rate (also used in this report as "turnover rate") is an alternate unit, measured as number of times inventory turns per year, also used to convert working storage capacity directly to warehouse working throughput. Turnover rate is calculated as total cost of cargo sold in a year divided by average cost of cargo in inventory at any given time in that year. It also is the inverse of cargo turnaround time.

Operating characteristics vary among BCOs and 3PLs and include factors, such as:

- Hours of operation (i.e., day shift only or 24/7);
- Types of products handled;
- Time sensitivity of products for distribution;
- Packaging and carton size;
- Outbound order picking of cartons or individual items, or both;
- Manual cargo handling or use of automated equipment (i.e., cargo put-away and retrieval systems, carton and item sortation systems, robots, etc.);
- Degree of IT systems automation; and
- Operating efficiency determined by optimal or inferior physical layout of the facility.

Inventory characteristics include:

- Length of time an SKU remains in inventory before being shipped;
- Total landed cost of SKU;[5]
- Whether an SKU is stored in one or multiple distribution centers or 3PL warehouses; and
- Number of pieces of the SKU being stored.

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[5] Landed cost is the total price of a product once it has arrived at a buyer's door. The landed cost includes the original price of the product, all transportation fees (both inland and ocean), customs, duties, taxes, insurance, currency conversion, crating, handling, and payment fees. http://blogs.pb.com/e-commerce/2013/05/15/what-is-a-landed-cost-and-why-its-essential-in-global-trade/.

2.0 Classification of Facility Types

This section discusses how cargo-handling facilities can be categorized and the rationale behind the method selected by the consulting team.

2.1 "Ideal" Classification of Warehouse Space

Classifying warehouse space was an essential precursor to updating the warehouse supply and demand model, because classification of warehouse space is important in terms of understanding the user markets for the space. The consulting team researched a variety of warehouse types. To elaborate, based on the consulting team's understanding, an ideal user markets classification system for warehouse space is one similar to that shown in Figure 2.1. For more detailed discussion on the classification methodology, refer to Task 2 Technical Memorandum.

Figure 2.1 An "Ideal" Warehouse Space User Markets Classification System

Tier I. Operator

At the highest tier (Tier I), warehouse space can be classified by operator of the warehouse buildings, specifically BCO or logistics service provider (LSP).[6] BCOs outsource logistics to 3PLs primarily to: 1) lower variable costs by making operations more efficient; 2) enable them to focus on core competencies (i.e., product manufacturing and retail marketing); and 3) reduce risks of fixed costs under changing market conditions. Whether serving a single BCO or multiple BCOs, the inventory characteristics of the facilities managed by 3PLs generally are dynamic and complex.

Tier II. Building Use

The next tier (Tier II) of the classification system addresses the use type of the building as a whole. Similar to the CoStar Property® Data Product definitions for warehouse building secondary types, namely, "Warehouse," "Distribution," "Truck Terminal," and "Refrigeration/Cold Storage," a warehouse can be categorized based on its predominant use, which is dependent upon operations and inventory characteristics.

Tier III. Functional Use of Space

Tier III, particularly in the context of Southern California, identifies the business focus of the operator, specifically, whether the stored cargo is port related (handled/processed at San Pedro Bay Ports) or not port related (not handled/processed at San Pedro Bay Ports). It is common for a warehouse to handle both types of cargo. A concurrent SCAG study on border-crossing freight flows provides data for separating out border-crossing-related stored cargo from port-related and nonport-related stored cargo.

Tier IV. Subfunctional Use of Space

An even lower hierarchical level for user markets can be specific port-related functional use, such as crossdock transloading; or specific nonport-related use, such as international border-crossing trade and domestic goods distribution. The knowledge of demand and/or physical, operational, or inventory parameters for subfunctional uses enables the policy-maker to develop alternate forecasts or analyze alternate scenarios.

2.2 Practical and Useful Classification of Warehouse Space

Currently, there is no comprehensive data source for Tier I classification information for the SCAG region. The differences between operator classes and variations within an operator class, especially in terms of their economic impacts, may be of interest to regional and local planning and policy-making, but due to data limitations, this is not evaluated as part of this study. The Task 3 technical report indicated some operator practices and trends that may influence the SCAG economy, and these could form the basis for further study on warehouse operators.

[6] In this study, the term LSP is used to represent a 3PL warehouse operator.

Tier II classification is directly supported by CoStar Property® data. The research in Task 2 identified typical physical and operational characteristics of several types of warehouse buildings, as summarized in Error! Reference source not found.. The physical size (e.g., square feet of building) and scale of operations (e.g., cargo turnover rate) of a facility can be directly related to its transportation generation potential. The size of a facility, its location, and its cargo demand signify its "last mile" access need, jobs impact, vehicle miles traveled impact, and emissions impact.

Tier III classification is relevant for a short duration when cargo is first moved from/to San Pedro Bay Ports. Once port- or nonport-related cargo is removed from the container, there is little to distinguish between them in terms of storage and handling processes. With port-related cargo, a BCO often has to assess the tradeoff between cost of transportation and cost of storage. Generally, the farther away from the port, the higher the cost of transportation, and the lower the cost of storage. Due to highly unreliable travel times on Southern California's road network during business hours, many BCOs locate close to the ports and are willing to bear the additional cost of storage.[7] This has a land use implication: the demand for suitable land for warehousing for port-related cargo is the highest in the cities close to the ports. The locations that are frequented by port-related cargo are based on some data and mostly empirical evidence. The inventory of warehousing, developed using CoStar Property® data, provides indirect evidence of locations heavily used by nonport-related cargo. There is no data on an individual facility basis identifying the relative usage for port- and nonport-related cargo. Overall, Tier III classification provides data-based foundation for evaluating regional public planning approaches and developing public policies around industrial facility developments in the SCAG region.

Tier IV classification provides the most detailed understanding of use of space within warehouse buildings. Definitions of some common types are as follows:

- General Purpose Warehouse (GPW). These warehouses are the oldest and the most common form of warehouses used to manage inventory operated primarily by 3PLs, where cargo-handling equipment usually is not sophisticated. Most port-related GPWs are located in commercial and industrial clusters, while nonport-related GPWs tend to be more dispersed throughout the region.
- Transload Facility (TF). This facility is a special purpose port-related warehouse with low-ceiling height and narrow, long building layout and located near ports, mainly used for import products, where the contents of approximately three 40-foot import marine containers are transferred into two domestic 53-foot containers or trailers for onward movement to an inland U.S. destination.
- Crossdock Transload Facility (CDF). This facility is a special type of transload facility, where transloading occurs in less than 24 hours. They are used for processing imports, exports, and domestic cargo.
- Truck Terminal for Less-Than-Truckload Trucks (TTLTL). A truck terminal is a special purpose warehouse operated by a motor carrier and used mainly to sort

[7] Note: "Close" is based on where the BCOs' target markets are located, and it varies from one BCO to another, depending on their geographical market area. For example, Gateway Cities could be considered close to one BCO, while the Inland Empire could be considered close to another whose market may be nationwide.

domestic and international products in small order quantities for onward distribution, typically in a regional geography.

- General Purpose Distribution Center. A distribution center is a special purpose warehouse operated by a BCO to store and distribute goods, which on average, have higher ceiling than GPWs, and are located strategically to maximize network effects and geographical coverage of customers and to minimize transportation cost.
- Retail Fulfillment Center (RFC). These are special-purpose distribution centers that have become more common in the supply chains of large retailers during the past five years, and are mostly mega-distribution centers, but with faster replenishment of cargo and narrow schedules of delivery to customers.

As shown in Table 2.1, some general characteristics can be drawn for this classification, though a comprehensive inventory of spaces classified in this manner may not be practical, and not all Tier IV classes may be useful from a regional public planning and policy-making perspective. For example, GPWs would be important from a redevelopment or renovation standpoint. RFCs may be significant from a growth in warehouse space perspective.

Other data such as San Pedro Bay Ports cargo data, Dr. Robert Leachman's port truck-based cargo stops information, CoStar Property® tenant data, Cambridge Systematics' "transload likely" analysis, etc. are used to complement CoStar Property® data to analyze specific Tier IV classes in this study.

Table 2.1 Typical Physical and Operational Characteristics of Warehouse Building Classes[a]

	Description of Typical Attribute by "Practical" User Market Class							
Attribute	**NPRGPW**	**PRGPW**	**TF Likely**	**CDF Likely**	**TTLTL**	**GDC**	**RFC Likely**	**RCSF**
Building location[a]	Not Specific	Not Specific	Depends on Proximity to Ports	Depends on Proximity to Ports	Not Specific	Depends on Proximity to Market	Depends on Land Availability	Depends on Proximity to Market
Typical Building area	25,000 to 50,000 sq. ft.	25,000 to 50,000 sq. ft.	Same as Typical Warehouses (>25,000 sq. ft.)	Same as Typical Warehouses (>25,000 sq. ft.)	25,000 to 150,000 sq. ft.	50,000 sq. ft. to 500,000 sq. ft.	500,000 to 1,000,000 sq. ft.	Same as Typical Warehouses (>25,000 sq. ft.)
Building Width	Not Specific	Not Specific	Long and Narrow	Long and Narrow	Long and Narrow	Not Specific	Not Specific	Not Specific
Typical building ceiling height	> 22 ft.	> 22 ft.	< 25 ft.	< 25 ft.	< 25 ft.	> 28 ft.	> 40 ft.	> 22 ft.
Site coverage	50%	50%	50%	50%	30%	40%	40%	50%
Office space as percentage of building area	20%	20%	20%	20%	10%	5%	5%	20%
Use of IT systems and automated equipment	Low	Low	Moderate	Moderate	Moderate	High	High	Moderate
Number of loading docks/ doors relative to the building area	1 per 15,000 sq. ft. of RBA	1 per 15,000 sq. ft. of RBA	1 per 15,000 sq. ft. of RBA	1 per 15,000 sq. ft. of RBA	1 per 3,000 sq. ft. of RBA	1 per 10,000 sq. ft. of RBA	1 per 10,000 sq. ft. of RBA	1 per 15,000 sq. ft. of RBA
Cargo turnaround time	Varies	Varies	Up to 1 week	1-2 days	Up to 1 week	Varies	Up to 1 week	Up to 1 week
Adjacent land use	Varies	Commercial/ Industrial	Varies	Commercial/ Industrial	Commercial/ Industrial	Commercial/ Industrial	Commercial/ Industrial	Varies

[a] Defined as a combination of Tiers II to IV Classification.

[b] All warehouse owners have a general preference for low-cost sites, and all warehouse operators have a general preference to be located at transportation nodes – near freeway interchanges, rail yards, etc. Direct rail access needs can vary depending on the commodity types handled. Key: NPRGPW – Nonport-related General Purpose Warehouse, PRGPW – Port-related General Purpose Warehouse, TF – Transload Facility, CDF – Crossdock Facility, TTLTL – Truck Terminal for Less-than-Truckload Trucks, GDC – General Distribution Center, RFC – Retail Fulfillment Center, and RCS – Refrigeration/Cold Storage Facility.

Sources: CoStar Property® Data, 2012 Counties Assessors Data, 2012 SCAG Parcel-Level Existing Land Use Data, 2012 SCAG Parcel-Level General Land Use Plan Data, 2014 Gateway Cities Industrial Warehouse Data, I 710 EIR, Published journal and online articles, and Cambridge Systematics' Analysis.

2.3 CARGO SUBMARKET TYPES FOR WAREHOUSE SPACE MODELING

As part of this study, a spreadsheet model was developed to forecast supply and demand for warehouse space in 43 geographical submarket areas of the SCAG region.[8] The model includes an inventory of warehouse space for 2014 and annual forecasts through 2040 for "port-related," "border-crossing-related," and "domestic" containerized cargo markets. The model includes a baseline forecast, and also can be used to test alternate regional planning and policy scenarios.

"Port related," in this technical memorandum, means only the containerized cargo that is handled at San Pedro Bay Ports, and does not include the containerized cargo that is handled at Port Hueneme or Port of San Diego. In 2015, these Ports handled about 0.5 percent and 0.6 percent of total port-related containerized cargo in Southern California, respectively;[9] and there is insufficient data on the priority submarket areas for storage of their containerized cargo. Therefore, containerized cargo that is handled at Port Hueneme and Port of San Diego is included in the other two containerized cargo markets. By "border-crossing related" in this report, we refer to only the majority (about 96 percent) of border-crossing freight flows that are not handled at San Pedro Bay Ports. The small portion (about 4 percent) of border-crossing freight flows that are handled at San Pedro Bay Ports are assumed to be included in the "port-related" cargo market.[10] "Domestic" cargo in this this technical memorandum is any other type of containerized cargo that is not classified as "port-related" or "border-crossing-related" cargo.

The warehouse space within a submarket area in the three cargo markets was divided into 13 "cargo submarket types," as shown in Table 2.2. There are 5 cargo submarket types under "port-related" cargo market, 5 cargo submarket types under "border-crossing-related" cargo market, and 3 cargo submarket types under "domestic" cargo market. These are similar to the practical and useful classes of warehouse space discussed in Section 2.2, but also reflective of the data limitations and approach used in the model calculations, which are described in Section 3.0 in more detail.

Small RDCs are defined as distribution center type buildings with rentable building area of less than 500,000 square feet; and mega-RDCs are defined as those with above or equal to 500,000 square feet.

Table 2.2 Cargo Submarket Types in Warehouse Space Model

Port-Related Cargo Submarket Types	
1	Import loads to crossdock transload facilities (CDF)

[8] SCAG region consists of the six Counties of Imperial, Los Angeles, Orange, Riverside, San Bernardino, and Ventura.

[9] http://www.pmanet.org/port-locations-stats (last accessed on June 1, 2016).

[10] Based on unpublished truck based origin-destination freight flows data in SCAG Goods Movement Border Crossing Study and Analysis – Phase II, last accessed on June 1, 2016.

2	Import loads to small regional distribution centers (< 500,000 sq. ft.)
3	Import loads to mega-regional distribution centers (>= 500,000 sq. ft.)
4	Import loads to import warehouses (also GPWs)
5	Export loads to export warehouses (also GPWs)
Border-Crossing-Related Cargo Submarket Types	
6	Import loads to crossdock transload facilities (TF)
7	Import loads to small RDC (< 500,000 sq. ft.)
8	Import loads to mega RDC (>= 500,000 sq. ft.)
9	Import loads to import warehouses (also GPWs)
10	Export loads to export warehouses (also GPWs)
Domestic Cargo Submarket Types	
11	Domestic loads to small RDCs (< 500,000 sq. ft.)
12	Domestic loads to mega RDCs (>= 500,000 sq. ft.)
13	Domestic loads to GPWs

Source: SCAG Warehouse Space Forecasting Model, Version 1.0 developed in June 2016.

3.0 Documentation of Warehouse Space Forecasting Model Baseline Scenario

3.1 Overview of Warehouse Space Forecasting Model

Figure 3.1 shows the contiguous geographical boundaries of the 43 submarket areas in the SCAG region. Each submarket area boundary coincides with the limits of commercial and industrial real estate development areas in the SCAG region, and were adopted from the boundaries defined by CoStar Property®, the real-estate data vendor for this study. The warehouse space outlined by a submarket area competes with the warehouse space in other submarket areas. The conditions within each submarket area, in terms of costs of leasing and construction per square foot of warehousing buildings, are relatively uniform. The submarket areas fall across multiple public jurisdictions; however, each city in the SCAG region is uniquely associated with a submarket area. Submarket areas are smaller in the interior or older urbanized parts of the SCAG region, but larger in the exterior or newer urbanized and rural parts of the SCAG region. The model estimates demand for 13 cargo submarket types, as shown earlier in Table 2.2. The demand in the future is constrained by available vacant warehouse space and available developable space for future warehousing.

As shown in Figure 3.2, the warehouse space forecasting model has three major components: 1) inputs, 2) calculations, and 3) outputs. A process diagram explaining the model also is shown in Figure 3.3.

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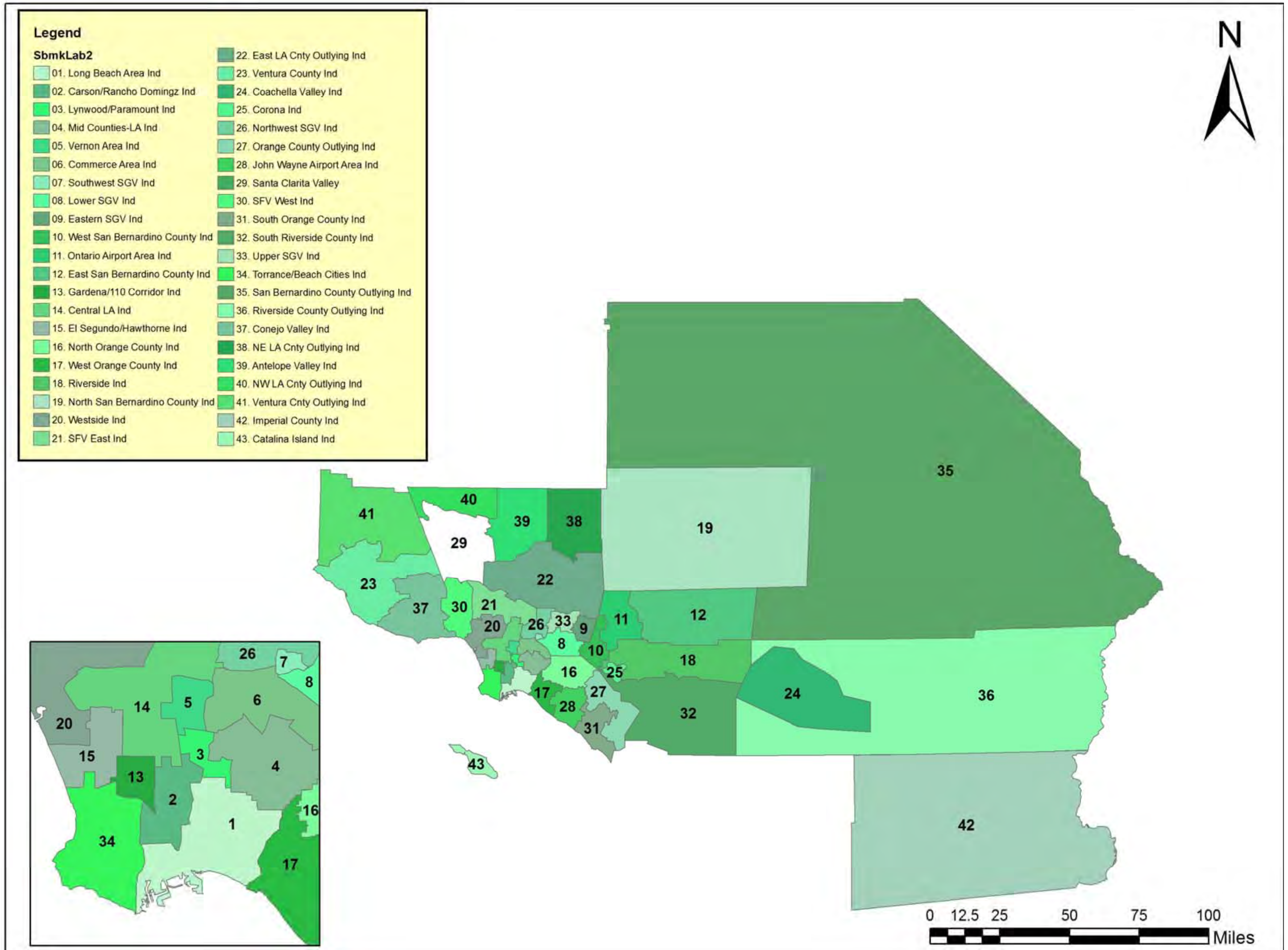
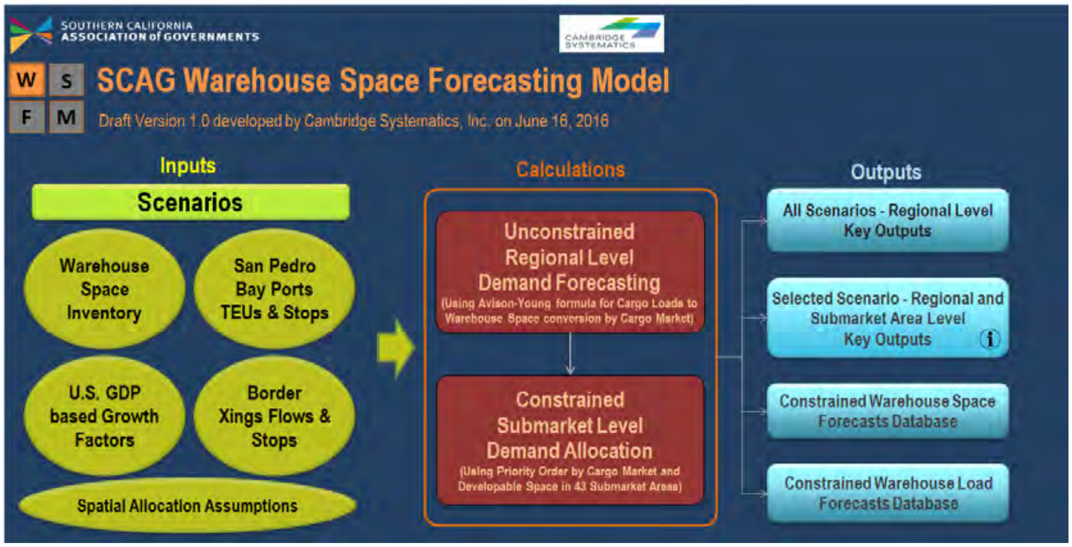
Figure 3.1 43 Submarket Areas in the SCAG Region



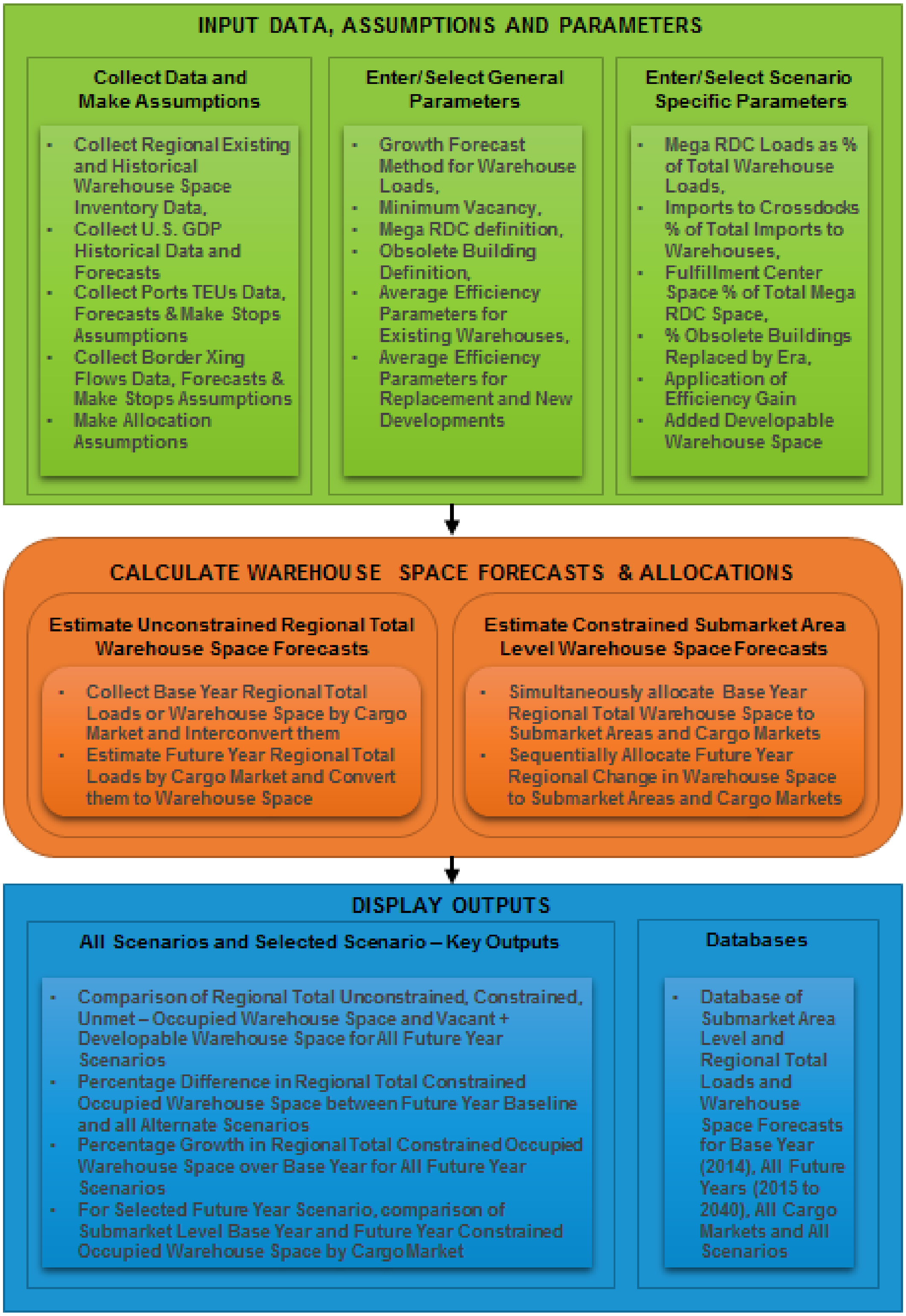
Sources: CoStar Property® Data – Submarket Area Maps; ESRI's Geographical Information System (GIS) data layers; and Cambridge Systematics' Development of Submarket Area GIS data layer, March 2015.

Figure 3.2 Overview Diagram of SCAG Warehouse Space Forecasting Model



Source: SCAG Warehouse Space Forecasting Model, Version 1.0, developed in June 2016.

Figure 3.3 Process Diagram of Warehouse Space Forecasting Model



Source: Cambridge Systematics, Inc.

The model has six main types of inputs, which include the following:

1. Warehouse space inventory. This input provides the regional total and submarket area-level occupied warehouse space in the base year (2014) and available vacant and developable warehouse space for future warehousing. It provides control totals for inventory with similar building uses in the base year (e.g., occupied and vacant space for small RDC, mega-RDCs, and other warehouses in 2014) by submarket area that are used to calculate the base year occupied warehouse space by cargo submarket type. It also provides share of retail fulfillment centers (RFC) out of total mega-RDCs space that is used to calculate the net cargo storage efficiency of mega-RDCs. This input is based on:
   a. Submarket area-level summary of CoStar Property's® November 2014 warehouse space inventory of occupied, vacant, and total warehouse space and related details (e.g., inventory by functional use type of building, building size, building height, building age, etc.).
   b. Submarket area-level estimates of 2014 developable building area for future warehousing, as calculated in Task 2 report.
   c. Model user input on minimum vacancy[11] by submarket area of existing and developable warehouse space; default input is 1.0 percent or existing vacancy, whichever is lower. This value can be altered by the model user within the "Scenarios" tab.
2. U.S. Gross Domestic Product (GDP)-based growth factors. This input is applied to base year total warehoused loads to project future total warehoused loads. The input is derived using the following:
   a. 2012 Regional Economic Impact Models Inc., (REMI) PI+ Version 3.6.1 economic model's historical (2004-2014) and forecasts from 2015 through 2040 for national GDP by year.
   b. CoStar Property's® historical (2004-2014) SCAG region-level occupied warehouse space.
   c. Model user selection on growth factor method applied to total warehoused loads. The two options available are: i) proportionate to U.S. GDP forecast; and ii) proportionate to projected SCAG region occupied warehouse space under no efficiency gain in cargo storage.

[11] Vacancy is a percentage value obtained by dividing vacant warehouse space by total existing warehouse space and multiplied by 100.

3. San Pedro Bay Ports containerized cargo forecasts and stops information. This input provides containerized cargo forecasts for all port-related cargo submarkets by year and direction of flow (import/export) measured in twenty-foot equivalent units (TEU). This input is derived using the following:
   a. San Pedro Bay Ports' QuickTrip[12] model-based mode splits by year and by direction of flow (import/export).
   b. Model user inputs on percentage of port-related import cargo that is warehoused and percentage of port-related export cargo that is warehoused; default input values are 100 percent and 30 percent, respectively. These values can be altered by the model user within the "Scenarios" tab.
   c. Dr. Robert Leachman's cargo stop assumptions for cargo imported through San Pedro Bay Ports, which are applied to mode splits for imports in all years.
4. Border-crossing freight flow forecasts and stops information. This input provides containerized loads for all border-crossing-related cargo markets warehousing by year and direction of flow (import/export) measured in TEUs. The input is derived using the following:
   a. Ongoing SCAG Goods Movement Border Crossing Study and Analysis – Phase II-based truck total and origin-destination flows.
   b. U.S. Department of Transportation (DOT), Bureau of Transportation Statistics, TransBorder Freight Data-based average payload for import truck from Mexico to California, which is rounded to 5,500 kg per truck.
   c. Model user inputs on average payload for export truck in kilograms per truck, import tons per TEU, and export tons per TEU; default input values are 5,500 kg per truck, 10 tons per TEU, and 10 tons per TEU, respectively. These values can be altered by the model user within the "Scenarios" tab.
   d. Model user inputs on percentage of border-crossing-related import cargo that is warehoused, and percentage of border-crossing-related export cargo that is warehoused; default input values are 100 percent and 100 percent, respectively. These values can be altered by the model user within the "Scenarios" tab.
   e. Model user inputs on border-crossing imports-related stop assumptions. Default inputs are 50 percent of the cargo imported through border crossing at Mexicali to the U.S., other than San Diego and Imperial Counties, are stored at crossdock transload facilities at Imperial County; and 25 percent of the cargo imported through border crossings at Tijuana and Mexicali to the U.S. leaving out San Diego and SCAG region are stored at regional distribution centers in the SCAG region. These values can be altered by the model user within the "Scenarios" tab.
5. Spatial allocation assumptions. This input is a compilation of several assumptions and is used in constrained submarket area-level demand allocation. There are assumptions that relate to base year (2014) spatial allocation of the SCAG region-level

[12] QuickTrip is a container truck trip generation spreadsheet model originally developed by Moffatt & Nichol, Engineers and enhanced by Cambridge Systematics.

demand for warehouse space, and those that relate to forecast years. This input is based on:

a. Cambridge Systematics' approximate counts of "transload likely" warehouses by submarket area using aerial imagery data.

b. CoStar Property's® November 2014 warehouse space inventory-based submarket-level inventory of small RDCs and mega-RDCs space.

c. Cambridge Systematics' estimates of port-related and domestic general purpose warehouse space allocation percentages in the year 2014 using Fratar method.[13]

d. SCAG Goods Movement Border Crossing Study and Analysis – Phase II origin-destination truck flows information.

e. Cambridge Systematics' priority orders for spatial allocation for all cargo submarket types using CoStar Property's® historical (2004-2014) SCAG submarket area-level change in occupied warehouse space by functional use (distribution centers and other warehousing) and estimates of developable space by submarket area.

6. Scenarios Input. This is a set of 18 inputs that model user selects from drop-down lists or enters manually. About 10 of these inputs are *general inputs* that allow the model user to modify the inputs to the baseline scenario, while the remaining 8 inputs are *scenario specific inputs* that are used to differentiate alternate scenario from the baseline scenario. Key inputs among them are cargo storage efficiency parameters by cargo submarket type for existing and replaced/new developments, which form a key basis for Avison-Young's (a real estate management company) formula (as described in Section 3.3 of this document) for converting warehoused loads to equivalent warehouse space values and vice versa.

   In addition, the "Scenarios" tab also contains the *run all scenarios* and *reset inputs to default values* buttons. While the general inputs are discussed in more detail in Section 3.2 of this report, the scenario specific inputs will be discussed in Task 5 report.

The model performs the following two main types of calculations:

1. Unconstrained SCAG region-level demand forecasting. This calculation estimates SCAG region-level demand for warehouse space by cargo submarket type and by forecast year. The calculation uses a formula developed by Avison-Young (a commercial real-estate services firm) to convert port-related, border-crossing-related, domestic and total load forecasts to warehouse space forecasts. The formula does not use information on the SCAG region-level or submarket area-level availability of vacant or developable warehouse space; hence, the warehouse space forecast is unconstrained.

[13] This is a trip distribution method used in the field of transportation engineering. The method determines a matrix of values that simultaneously satisfy current row and column control totals. An initial balanced matrix of values is available for previous row and column control totals. Over multiple iterations, the values in the initial balanced matrix are adjusted till the current row and column control totals are approximately met. In the context of this study, the row totals refer to regional total for port-related and domestic general purpose warehouse space, while the column totals refer to total general purpose warehouse space in a submarket area. Also, in the context of this study, initial balanced matrix is drawn from the 2013 SCAG Comprehensive Regional Goods Movement Plan and Implementation Strategy.

2. **Constrained submarket area-level demand allocation**. This calculation allocates the estimated SCAG region-level demand for warehouse space by cargo submarket type spatially to the 43 submarket areas. In the base year (2014), the SCAG region-level warehouse space is simultaneously allocated to all submarket areas and cargo submarket types, depending on existing warehouse space inventory and spatial allocation assumptions. In the forecast years, the SCAG region warehouse space is sequentially allocated to all submarket areas and cargo submarket types, depending on available vacant and developable space and spatial allocation assumptions, and iterated until the last forecast year of 2040. From the year when available vacant and developable space for warehousing are completely filled out, unmet demand by cargo submarket type is estimated for this year onward.

The model generates the following four main types of outputs upon clicking *run all scenarios* button within the "Scenarios" tab:

1. **All scenarios – SCAG region-level key outputs**. This output module contains charts and tables only at SCAG region level. This module compares unconstrained, constrained, and unmet total warehouse space and remaining total vacant and developable warehouse space for all scenarios and for all years. This module also provides the breakout of warehouse space and warehoused loads by cargo submarket for all scenarios and for a selected future year against the base year of 2014.
2. **Selected scenario – SCAG region and submarket area-level key outputs**. This output module contains charts and tables, both at submarket area level and at SCAG region level, but only for selected scenario. This module shows constrained warehouse space and remaining total vacant and developable warehouse space under the selected scenario for all years. This module also provides the breakout of warehouse space and warehoused loads by cargo submarket type under the selected scenario and for a selected future year against the base year of 2014. In addition, the module provides a comparison of occupied warehouse space at SCAG region level, county level, and submarket area level under the selected scenario between the base year of 2014 and a selected future year.
3. **Warehouse space forecasts database**. To prepare quick summaries of warehouse space forecasts by year, by geography, by cargo submarket types, and by scenario, a database of warehouse space forecasts database is generated as an output to this model.
4. **Warehoused load forecasts database**. To prepare quick summaries of warehoused load forecasts by year, by geography, by cargo submarket types, and by scenario, a database of warehoused load forecasts database is generated as an output to this model.

Aside from the outputs described above, some interim charts and tables also are included in the model to easily understand and interpret the inputs. These include: 1) summary charts for occupied, vacant, and developable warehouse space in the SCAG region, its counties, and submarket areas in the base year of 2014; 2) a comparison chart for GDP-based growth factor options by year; 3) a comparison chart for port-related total loads versus warehoused loads by year; and 4) summary tables for border-crossing-related total freight flows and warehoused loads by year.

More details about the inputs, calculations, and outputs under the baseline scenario of the warehouse space forecasting model are described in Sections 3.2 to 3.4 of this document. The definitions, inputs, calculations, and outputs for alternate scenarios of the warehouse space forecasting model are described in the Task 5 report.

3.2 Details on Model Inputs for Baseline Scenario

Existing Inventory of Warehouse Space and Developable Space for Future Warehousing

An inventory of occupied, vacant, and total warehouse space was compiled using CoStar Property® database in this study. Warehouse space modeling in this study made use of the more detailed warehouse inventory downloaded in November 2014, instead of the less detailed warehouse inventory in 2014 year-end. The November 2014 data provided flexibility to summarize the warehouse inventory based on building use, size, age, etc. by submarket area. Estimates of developable space for future warehousing were made in this study by combining CoStar Property® inventory with the 2012 SCAG parcel-level existing land uses data and 2012 SCAG parcel-level general land use plan data. More details about the existing warehouse inventory and estimation of developable space for future warehousing are included in the Task 2 report of this study.

Table 3.1 shows a summary of the 2014 occupied, vacant, developable, and total warehouse space data for the 43 submarket areas in the SCAG region. It also shows that the occupied warehouse can be broken down into three functional use classes, namely, 1) small RDCs, 2) mega-RDCs, and 3) other warehouses. Building use helps distinguish regional distribution center type and other type warehouses. Among regional distribution center type warehouses, a building size definition of equal to 500,000 square feet or more was selected to represent mega-RDCs.

In November 2014, the SCAG region had a vacancy of approximately 3.4 percent, or about 39.7 million square feet of vacant warehouse building area. The existing amount of developable warehousing building area was estimated to be about 388.4 million square feet. A portion of the SCAG region total warehousing building area, also defined as minimum vacancy, is expected to remain unavailable for tenant occupation. The reasons for unavailability can include the warehouse building is being vacated, being renovated, or being marketed to new tenants. The warehouse space modeling in this study generally assumed the minimum vacancy in submarket areas to be 1 percent of the total warehouse building area. However, there are some submarket areas in the SCAG region that have existing vacancy even below 1 percent; for them the existing vacancy was used as the minimum vacancy.

Available vacant and developable warehouse building areas in submarket areas were computed from total vacant and developable warehouse building areas in a submarket area by multiplying them with *one minus minimum vacancy* for that submarket area. As a result, the available vacant building area in the SCAG region is reduced from 39.7 million to 28.5 million square feet; and available developable building area in the SCAG region is reduced from 388.4 million to 335.0 million square feet. This brings the total to about 363.5 million, or about 24.0 percent of the existing occupied warehouse space.

At the SCAG region level, the percentage shares for the different functional uses in terms of occupied warehouse space in 2014 were as follows: 1) small RDC – 12.9 percent; 2) mega-RDC – 9.3 percent, and 3) Other warehouses – 77.8 percent. The total for these percentages is 100 percent.

Table 3.1 Existing Inventory of Warehouse Space and Developable Building Area for Future Warehousing by Submarket Area in the SCAG Region, November 2014
Thousands of Square Feet

No.	Submarket Area	County	2014 Existing Occupied Building Area	2014 Existing Vacant Building Area	2014 Existing Total Building Area	2014 Estimated Developable Building Area	2014 Existing and Estimated Developable Total Building Area	2014 Existing Small Regional Distribution Center Occupied Building Area	2014 Existing Mega Regional Distribution Center Occupied Building Area	2014 Existing Other Warehouse Occupied Building Area
1	Long Beach Area Ind	Los Angeles	15,431	656	16,086	6,975	23,062	1,360	0	14,071
2	Carson/Rancho Domingz Ind	Los Angeles	58,063	1,491	59,554	8,572	68,125	14,585	0	43,478
3	Lynwood/Paramount Ind	Los Angeles	8,213	85	8,299	0	8,299	716	552	6,946
4	Mid Counties-LA Ind	Los Angeles	58,491	2,039	60,530	2,460	62,990	10,392	1,578	46,521
5	Vernon Area Ind	Los Angeles	47,418	744	48,162	11,532	59,694	2,404	880	44,133
6	Commerce Area Ind	Los Angeles	52,349	1,451	53,800	1,681	55,481	8,893	2,071	41,384
7	Southwest SGV Ind	Los Angeles	6,339	64	6,403	0	6,403	222	0	6,117
8	Lower SGV Ind	Los Angeles	63,737	1,437	65,174	24,590	89,763	7,486	5,474	50,778
9	Eastern SGV Ind	Los Angeles	18,764	336	19,100	0	19,100	2,119	790	15,855
10	West San Bernardino County Ind	San Bernardino	41,460	2,841	44,300	0	44,300	8,470	1,084	31,906
11	Ontario Airport Area Ind	San Bernardino	159,545	7,370	166,915	93,197	260,112	25,461	24,223	109,862
12	East San Bernardino County Ind	San Bernardino	69,335	3,521	72,855	0	72,855	9,246	32,676	27,413
13	Gardena/110 Corridor Ind	Los Angeles	20,659	750	21,409	3,380	24,789	2,438	0	18,221
14	Central LA Ind	Los Angeles	54,367	1,395	55,762	13,294	69,056	2,594	2,117	49,656
15	El Segundo/Hawthorne Ind	Los Angeles	9,895	334	10,229	587	10,816	812	0	9,083
16	North Orange County Ind	Orange	63,803	2,021	65,824	4,040	69,864	6,232	1,617	55,954
17	West Orange County Ind	Orange	20,847	589	21,437	0	21,437	2,769	0	18,079
18	Riverside Ind	Riverside	72,430	3,106	75,535	47,289	122,824	12,328	19,465	40,637
19	North San Bernardino County Ind	San Bernardino	11,208	1,169	12,377	26,004	38,381	822	3,177	7,209
20	Westside Ind	Los Angeles	8,335	211	8,546	0	8,546	778	0	7,557
21	SFV East Ind	Los Angeles	54,897	1,303	56,201	655	56,856	4,005	0	50,892
22	East LA Cnty Outlying Ind	Los Angeles	17	6	22	0	22	0	0	17
23	Ventura County Ind	Ventura	25,676	981	26,658	4,600	31,258	2,135	0	23,541
24	Coachella Valley Ind	Riverside	6,742	662	7,405	24,356	31,760	559	0	6,184
25	Corona Ind	Riverside	15,899	247	16,146	746	16,892	1,248	0	14,652
26	Northwest SGV Ind	Los Angeles	11,367	258	11,625	0	11,625	1,388	0	9,979
27	Orange County Outlying Ind	Orange	240	0	240	0	240	0	0	240
28	John Wayne Airport Area Ind	Orange	35,994	893	36,886	0	36,886	1,855	0	34,139
29	SCV/Lancaster/Palmdale Ind	Los Angeles	11,537	302	11,839	0	11,839	1,997	0	9,540

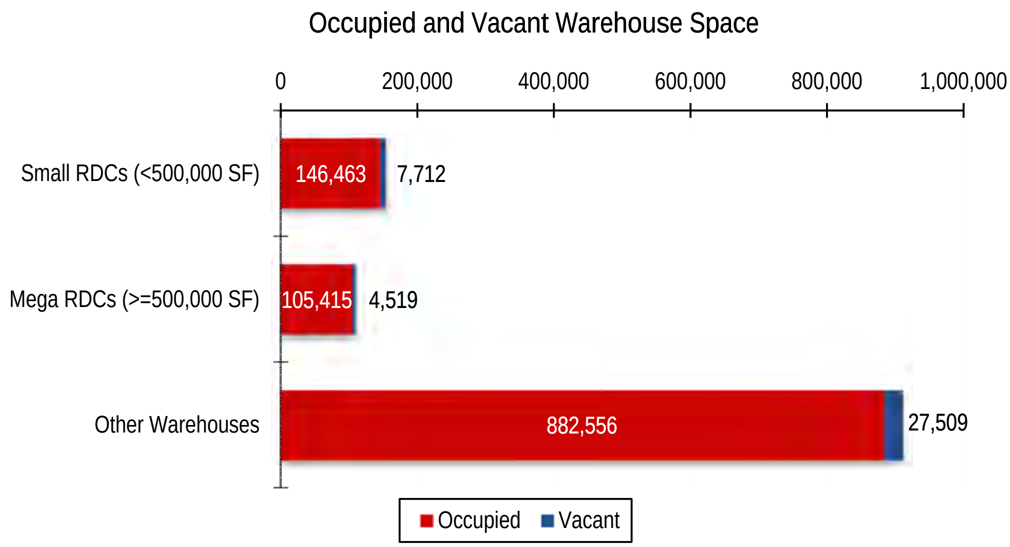
Table 3.1 Existing Inventory of Warehouse Space and Developable Building Area for Future Warehousing by Submarket Area in the SCAG Region, November 2014 (continued)
Thousands of Square Feet

No.	Submarket Area	County	2014 Existing Occupied Building Area	2014 Existing Vacant Building Area	2014 Existing Total Building Area	2014 Estimated Developable Building Area	2014 Existing and Estimated Developable Total Building Area	2014 Existing Small Regional Distribution Center Occupied Building Area	2014 Existing Mega Regional Distribution Center Occupied Building Area	2014 Existing Other Warehouse Occupied Building Area
30	SFV West Ind	Los Angeles	20,516	248	20,764	3,925	24,690	1,378	509	18,629
31	South Orange County Ind	Orange	14,323	287	14,610	3,653	18,263	2,282	0	12,040
32	South Riverside County Ind	Riverside	22,015	1,207	23,223	11,184	34,407	1,859	6,860	13,297
33	Upper SGV Ind	Los Angeles	15,988	252	16,240	0	16,240	1,024	0	14,964
34	Torrance/Beach Cities Ind	Los Angeles	22,402	471	22,873	1,488	24,361	5,050	1,430	15,921
35	San Bernardino County Outlying Ind	San Bernardino	106	11	117	0	117	0	0	106
36	Riverside County Outlying Ind	Riverside	112	0	112	0	112	0	0	112
37	Conejo Valley Ind	Los Angeles	9,209	467	9,676	2,180	11,856	1,113	0	8,095
38	NE LA Cnty Outlying Ind	Los Angeles	0	0	0	0	0	0	0	0
39	Antelope Valley Ind	Los Angeles	5,166	110	5,276	41,984	47,260	140	914	4,112
40	NW LA Cnty Outlying Ind	Los Angeles	0	0	0	0	0	0	0	0
41	Ventura Cnty Outlying Ind	Ventura	0	0	0	0	0	0	0	0
42	Imperial County Ind	Imperial	1,540	426	1,965	0	1,965	306	0	1,234
43	Catalina Island Ind	Los Angeles	2	0	2	0	2	0	0	2
Total			1,134,435	39,741	1,174,176	338,372	1,512,548	146,463	105,415	882,556
Percentage of Existing Occupied			100.0%					12.9%	9.3%	77.8%
Percentage of Existing Total			96.6%	3.4%	100.0%					
Percentage of Existing and Estimated Developable Total			75.0%	2.6%	77.6%	22.4%	100.0%			

Source: SCAG Warehouse Space Forecasting Model, Version 1.0 developed in June 2016.

Figure 3.4 shows the distribution of occupied and vacant warehouse space between the three function uses of warehouse buildings.

Figure 3.4 Existing Warehouse Space Inventory by Functional Use of Warehouse Building in the SCAG Region, 2014
Thousands of Square Feet



Source: SCAG Warehouse Space Forecasting Model, Version 1.0 developed in June 2016.

Further, the percentage splits between small and mega-RDCs occupied warehouse space in 2014 are 58.1 percent and 41.9 percent, respectively. The total for these percentages is 100 percent. Under the baseline scenario, these splits are kept the same for all forecast years.

Retail fulfilment centers, as a special category of functional use of warehouse space, were identified from the CoStar databases on tenants and warehouse properties. Particular tenant companies, such as Uline, Home Depot, Amazon, ACT Fulfillment, etc. that are located in mega-RDC type warehouses, were identified as retail fulfillment center type in this study. In terms of space, these properties formed a share of 71 percent of total mega-RDCs. Under the baseline scenario, this share was kept the same for all forecast years.

Although, CoStar Property® database does not identify port imports-related crossdock transload facilities and border-crossing imports-related crossdock transload facilities, their share of total warehoused loads and warehouse space demand was estimated and allocated using other input data and assumptions.

The various warehouse buildings by functional use and cargo market (cargo submarket type) are expected to differ from each other in terms of cargo storage efficiency parameters in Avison-Young's formula (as described later in Section 3.3 of the document). Two parameters that are distinctly different are average building height and average cargo turnover rate. For existing warehouse space inventory, average building height was assumed to vary from 8 feet for crossdock transload facilities to 30 feet for mega-RDCs, while turnover rate was assumed to vary from 12 turns per year for general purpose warehouse to 300 turns per year for crossdock transload facilities.

The warehouse space inventory also varies significantly by submarket area. Figure 3.5 shows a graphical format of the occupied, vacant, and developable warehouse space inventory by submarket area in the SCAG region. In terms of occupied warehouse space share of SCAG region total, Ontario Airport industrial area leads at 159.5 million square feet (14.1 percent), followed by Riverside industrial area at 72.4 million square feet (6.4 percent) in the second position, and East San Bernardino County industrial area at 69.3 million square feet (6.1 percent) in the third position (see Table 3.1 for space specificities of each submarkets). In terms of vacant warehouse space share of SCAG region total, again Ontario Airport industrial area leads at 7.3 million square feet (18.5 percent), followed by East San Bernardino County industrial area at 3.5 million square feet (8.9 percent) and Riverside industrial area at 3.1 million square feet (7.8 percent). In terms of developable warehouse space share of SCAG region total, the top three submarket areas are Ontario Airport industrial area at 93.2 million square feet (27.5 percent), Riverside industrial area at 47.3 million square feet (14.0 percent), and Antelope Valley industrial area at 42.0 million square feet (12.4 percent).

U.S. GDP-Based Growth Factors for Total Warehoused Loads

Two growth factor methods were developed to forecast total warehoused loads in the SCAG region, which are as follows:

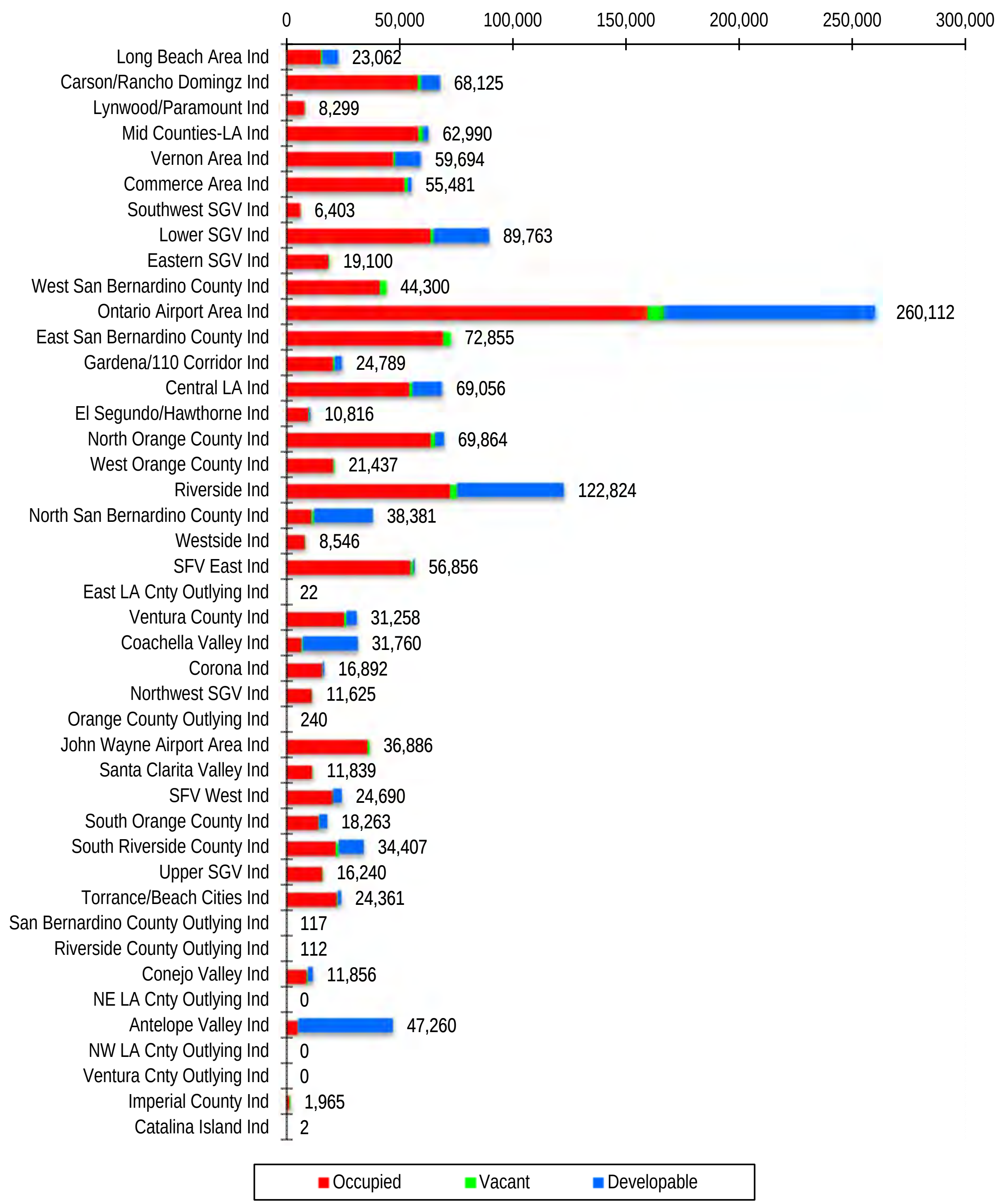
1. Growth factors that are directly proportional to U.S. GDP forecast given by 2012 REMI PI+ Version 3.6.5 economic model;[14] and
2. Growth factors that are proportional to projected SCAG Region Occupied Warehouse Space using a statistical relationship between historical U.S. GDP and SCAG Region Occupied Warehouse Space, and applying this relationship on U.S. GDP forecast given by 2012 REMI PI+ Version 3.6.5 economic model.

The model user can select one of these growth factor methods as input to region-level unconstrained demand forecasting. The first method uses the REMI PI+ Version 3.6.5 economic model-based U.S. GDP by year, as shown in Figure 3.5, to compute growth factors, while the second method is explained in more detail below, and finally a comparison of the growth factors using the two methods is presented.

[14] Regional Economic Impact Models Inc., http://www.remi.com/products/pi (last accessed on June 1, 2016).

Figure 3.5 Existing Warehouse Space Inventory and Developable Warehouse Space by Submarket Area in the SCAG Region, 2014

Thousands of Square Feet



Source: SCAG Warehouse Space Forecasting Model, Version 1.0, developed in June 2016.

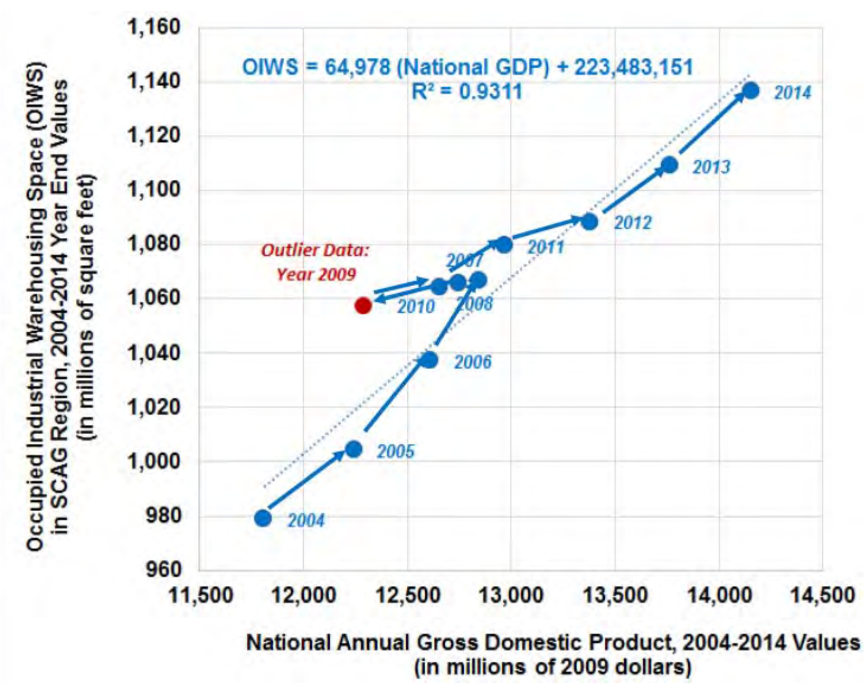
Table 3.2 U.S. GDP Forecast in Five-Year Intervals *Billions of 2009 Dollars*

Year	U.S. GDP
2014	$14,158
2015	$14,681
2020	$16,949
2025	$18,923
2030	$20,988
2035	$22,942
2040	$25,053

Source: 2012 REMI PI+ Version 3.6.5 economic model.

As shown in Figure 3.6, the historical national GDP was found to be strongly related to CoStar Property's® historical SCAG region-level occupied warehouse space for the corresponding years. Hence, a statistical relationship was established between the two variables for the historical years and was used to project future SCAG region-level occupied warehouse space.

Figure 3.6 Relationship between Occupied Warehouse Space in the SCAG Region and National Annual GDP Using 2004-2014 Data



Source: SCAG Warehouse Space Forecasting Model, Version 1.0 developed in June 2016.

Note: The chart represents a scatter plot, so data is not chronologically ordered.

Historical data showed that, on average, the rate of change in the SCAG region level of occupied warehouse space (OWS) is slightly slower than the rate of change in the national GDP. A linear regression with a nonzero intercept was, therefore, selected as the model structure, and the model parameters were estimated as shown below. The sign and magnitude of model coefficients are found to be appropriate, and they also satisfied Student's t-test of significance.[15] The model showed an excellent statistical fit:

$$\text{OWS} = 64{,}978\,(National\ GDP) + 223{,}483{,}152$$

Where:

OWS = Occupied warehousing building area in square feet

GDP = Gross Domestic Product in billions of 2009 dollars

with

R-square = 0.9311, Adjusted R-square = 0.9225

and t-statistics for

Coefficient of GDP: t-value = 10.40, Pr > |t| = <.0001

Intercept: t-value = 2.76, Pr > |t| = 0.02450

Historical data on OWS was obtained only for the SCAG region. Historical data for competing regions was not available for this study. Thus, more complex statistical models that reflective competitive factors among regions were not built.

There are likely lag and lead effects that influence quarterly changes in the SCAG region-level OWS. For example, the completion of a new warehouse in a quarter and marketing of the developed space may increase OWS in the next or the following quarters. However, this study focused on long-term annual forecasts and did not model these lag/lead effects that are relevant to short-term quarterly forecasts.

Historically, the demand for warehouse space was unconstrained; that is, there was more warehouse space available than the demand for warehouse space, as evidenced by positive vacancy rates for the years 2004-2014 in CoStar Property® data. Hence, using the estimated model for forecasting based on national GDP forecasts would provide SCAG region-level unconstrained demand for warehouse space.

On the other hand, there is a key limitation in using the growth factors projected by the statistical model to estimate future warehouse space. As the statistical model does not have any parameter for cargo storage efficiency, the space needed per-unit cargo will remain a constant. This would make SCAG region total warehouse space forecasts using the statistical model inelastic to model user inputs on efficiency gain. To address this limitation, the growth factors projected by the statistical model were applied to total warehoused loads. The resulting warehoused loads estimates also would represent unconstrained demand. In summary, the growth in U.S. GDP would affect the growth in total warehoused cargo

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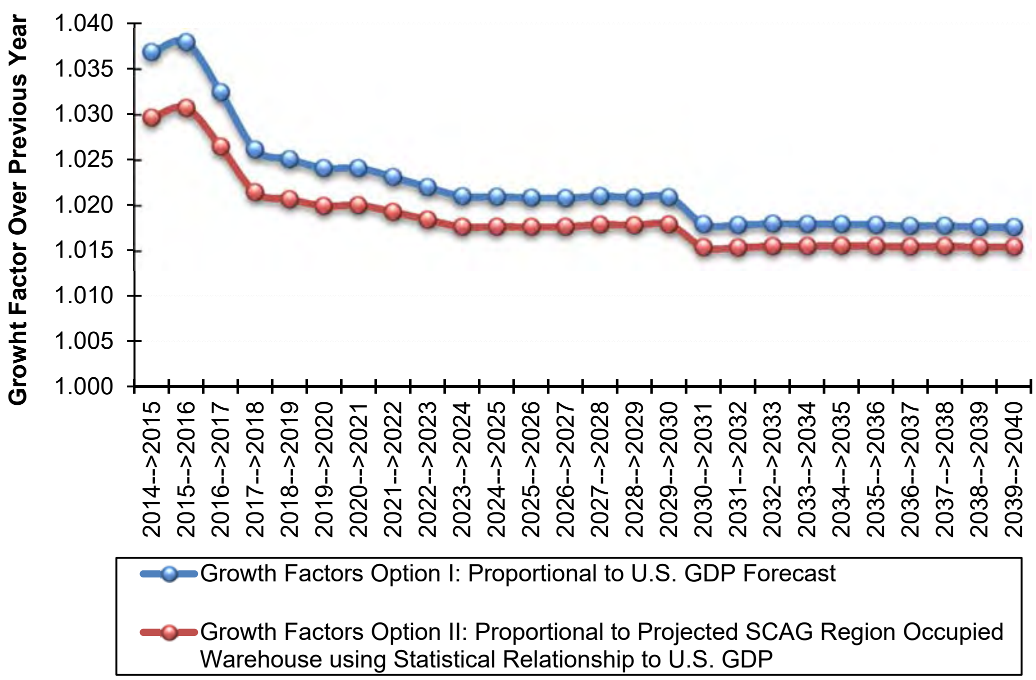
[15] Student's t-test, in statistics, is a common and popular method of testing hypotheses about the mean of a small sample drawn from a normally distributed population when the population standard deviation is unknown. In 1908, William Sealy Gosset, an Englishman publishing under the pseudonym Student, developed the t-test and t distribution.

demand via the statistical model, and the model user would be able to modify cargo storage efficiency to estimate warehouse space needed to store the cargo forecast.

Under the baseline scenario, where there is no efficiency gain assumed in cargo, the growth in warehoused loads and warehouse space would follow a similar trajectory; a small difference would, however, exist due to the changes in mix of cargo submarket types between the base year and forecast years. Based on the SCAG region-level calculations (as described in Section 3.4 of this document), under the baseline scenario, the SCAG region-level unconstrained warehoused loads are expected to grow from 50.1 million TEUs in 2014 to 81.1 million TEUs by 2040. This represents a 62-percent overall growth and an average annualized growth rate of 1.87 percent. At the same time, unconstrained occupied warehousing space is expected to grow from 1.134 billion square feet in 2014 to 1.809 billion square feet by 2040. This represents a 60-percent overall growth and an average annualized growth rate of 1.81 percent.

Figure 3.7 shows a comparison of year-to-year growth factors based on both U.S. GDP-based growth factor methods. Under the second option using the statistical model, the growth factors would result in an average annualized growth rate in warehoused loads of 1.87 percent, which is lower than 2.22 percent, that would result when using direct U.S. GDP forecast-based growth factor method.

Figure 3.7 Comparison of U.S. GDP-Based Growth Factors for Total Warehoused Loads



Source: SCAG Warehouse Space Forecasting Model, Version 1.0 developed in June 2016.

San Pedro Bay Ports Containerized Cargo Forecasts and Port-Related Truck-Based Cargo Stops Information

The San Pedro Bay Ports are both regionally and nationally important international trade gateways. They provide significant contributions to containerized cargo in Southern California, and make use of a substantial portion of the existing warehousing inventory.

The ports have developed containerized cargo forecasts, as shown in Table 3.3. This was used in the baseline scenario of the warehouse space forecasting model. As shown in this table, port-related total cargo is expected to increase by 135 percent between 2014 and 2040, or at an average annualized growth rate of 3.3 percent. The growth rate in the port-related cargo is much higher than the SCAG region total occupied warehouse space in the same time period. Therefore, it would result in an increase in share of the port-related cargo over time. Based on the SCAG region-level calculations (as described in Section 3.4 of this document), under the baseline scenario, the share of port-related occupied warehouse space will increase from 11.2 percent in 2014 to 14.3 percent by 2040.

Table 3.3 San Pedro Bay Ports' Containerized Cargo Forecasts in Five-Year intervals
TEUs

Year[a]	Inbound Loads	Outbound Loads	Total Loads	Empties	Total
2014	7,787,274	3,536,409	11,323,683	3,837,191	15,160,874
2015	8,254,382	3,455,806	11,710,188	4,141,863	15,852,050
2020	11,601,339	4,929,238	16,530,577	5,296,423	21,827,000
2025	14,563,777	6,561,895	21,125,672	6,565,328	27,691,000
2030	17,952,519	8,553,785	26,506,304	8,056,696	34,563,000
2035	18,310,083	9,174,350	27,484,434	8,210,566	35,695,000
2040	18,072,782	9,526,769	27,599,551	8,095,449	35,695,000

Source: Port of Los Angeles, March 2016.

[a] Year 2014 is actual; values for remaining years are forecasts.

Aside from the total cargo forecasts, the ports also estimate cargo market splits using their QuickTrip model. This model predicts the number of container truck trips arriving and leaving the container terminal over a 24-hour weekday. According to QuickTrip, port-related containers include the cargo types of inland point intermodal (IPI)[16] import loads, crossdock

[16] IPI is a "push logistics" type strategy used by many BCOs trading through the San Pedro Bay Ports, where the import loads from and export loads to the ports are moved in intact marine containers to or from inland locations in U.S. (respectively) without any stop at a warehouse in Southern California, with no value added services, and predominantly by rail.

transload import loads, non-crossdock transload import loads, pure local import loads[17], IPI export loads, pure local export loads,[18] and empty containers.

None of the IPI import loads or export loads is expected to stop in the SCAG region. About 100 percent of non-IPI import loads are expected to have at least one warehouse stop in the SCAG region. Cambridge Systematics assumed that only 30 percent of pure local export loads, on the other hand, are expected (under the baseline scenario) to have a warehouse stop in the SCAG region; and the remaining 70 percent of pure local export loads are bulk products (scrap steel, scrap paper), which would not need traditional warehouse storage; they may use bulk cargo yards or container storage lots. The model user also has the ability to alter a general input in the "Scenarios" tab of the warehouse space forecasting model to increase the percentage of pure local export loads with a warehouse stop to 100 percent.

In addition, Dr. Leachman developed an empirical distribution of the stops made by port drayage trucks after the imports leave the ports (see Table 3.4). As shown in this table, about 22.2 percent of the total non-IPI import loads stop more than once in the SCAG region, and 11.2 percent of the total non-IPI import loads stop more than twice in the SCAG region.

Table 3.4 Empirical Distribution of Non-IPI Import Cargo Stop Chain Types

Stop Chain Type for Non-IPI Import Cargo	Percentage Share of Total
One stop at a General Purpose Warehouse (GPW)	49.6%
One stop at a RDC	16.4%
One stop at a Crossdock Transload Facilities (CDF)	11.8%
One stop at a GPW, and then one stop at a RDC	4.5%
One stop at a CDF, and then one stop at a GPW	0.6%
One stop at a CDF, and then one stop at a RDC	5.9%
One stop at a CDF, then one stop at a GPW, and then one stop at a RDC	11.2%
Total for All Stop Chain Types	100.0%

Source: Derived from unpublished analysis by Dr. Robert C. Leachman, University of California (UC) Berkeley, 2009, conducted for the 2013 SCAG Comprehensive Goods Movement Plan and Implementation Strategy.

[17] These refer to imported cargo that is fully consumed in the geographical area, where the San Pedro Bay Ports serve as the closest waterborne port of entry.

[18] These refer to export cargo that is produced in the SCAG region, as opposed to IPI export, where the goods are transported to the San Pedro B ports intact in the marine containers from outside of the SCAG region, primarily by rail.

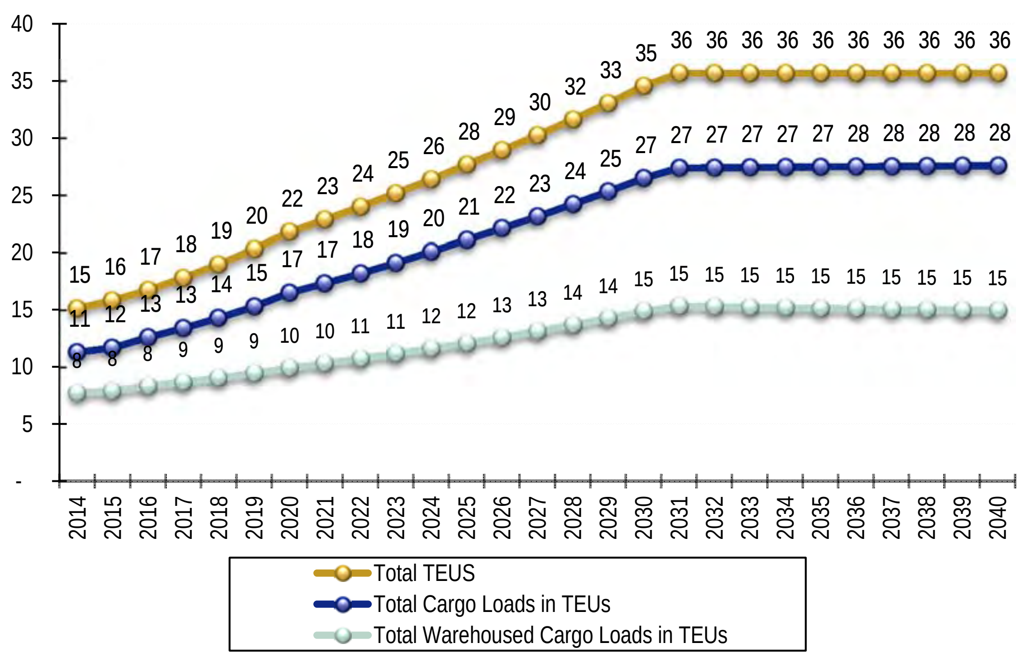
To estimate more accurate demand for warehouse space non-IPI import cargo, these stop chains were disaggregated to cargo stops and aggregated to functional use types of warehouse buildings. The resulting demand in terms of non-IPI import cargo stops in the year 2014 is as follows:

1. GPW – 65.9 percent of non-IPI import cargo stop chains
(= 49.6 percent + 4.5 percent + 0.6 percent + 11.2 percent);
2. RDC – 38.0 percent of non-IPI import cargo stop chains
(= 16.4 percent + 4.5 percent + 5.9 percent + 11.2 percent); and
3. CDF – 29.5 percent of non-IPI import cargo stop chains
(= 11.8 percent + 0.6 percent + 5.9 percent + 11.2 percent).

The total for these shares is 133 percent. In other words, in the year 2014, on average, every non-IPI import cargo load produced about 1.33 stops. By 2040, on average, every non-IPI import cargo load is expected to produce about 1.36 stops.

Figure 3.8 shows the port-related total throughput, total loads, and total warehoused loads. The total warehoused loads, including warehoused non-IPI import loads and warehoused non-IPI export loads, make up about 43.8 percent of total ports throughput in TEUs in 2014; and are expected to drop under the baseline scenario to 38.4 percent of the total throughput in TEUs by 2040.

Figure 3.8 San Pedro Bay Ports-Related Total Throughput, Total Loads, and Warehoused Loads in TEUs, 2014-2040, Total Throughput versus Total Loads versus Warehoused Loads
Millions of TEUs



Sources: Port of Los Angeles, March 2016; and Cambridge Systematics' Analysis.

Based on the SCAG region-level calculations (as described in Section 3.4 of this document), under the baseline scenario, the port-related warehoused import loads make up about 41 percent of total ports throughput in TEUs in 2014, and are expected to drop under the baseline scenario to 37 percent of the total ports throughput in TEUs by 2040. In terms of TEUs, however, the port-related warehoused import loads would increase from 6.2 million TEUs in 2014 to 13.2 million TEUs by 2040; that is, by 113 percent or at an average annualized growth rate of 3.0 percent. In terms of warehouse space, the port-related warehoused import loads would increase from 113.7 million square feet in 2014 to 244.4 million square feet by 2040; that is, by 115 percent or at an average annualized growth rate of 3.0 percent. In terms of share of total demand for warehouse space, the port-related warehoused import loads make up about 10 percent in 2014, and 14 percent in 2040.

Also, based on the SCAG region-level calculations (as described in Section 3.4 of this document), under the baseline scenario, the port-related warehoused export loads make up about 3.2 percent of total ports throughput in TEUs in 2014, and are expected to drop to 1.5 percent of the total ports throughput in TEUs by 2040. In terms of TEUs, however, the port-related warehoused export loads would increase from 0.48 million TEUs in 2014 to 0.55 million TEUs by 2040; that is, by 14 percent or at an average annualized growth rate of 0.5 percent. In terms of warehouse space, the port-related warehoused export loads would increase from 12.8 million square feet in 2014 to 14.7 million square feet by 2040; that is, by 14 percent or at an average annualized growth rate of 0.5 percent. In terms of share of total demand for warehouse space, the port-related warehoused export loads make up about 1.1 percent in 2014, and 0.8 percent in 2040.[19]

Border-Crossing Freight Flow Forecasts and Stops Information

The crossings along California-Baja California border, namely, Tijuana and Mexicali, are regionally important international trade gateways. They handle important products, such as electronics, heavy machinery, automobiles, medical devices, etc. According to SCAG Goods Movement Border Crossing Study and Analysis – Phase II, about 2.4 million trucks crossed Tijuana and Mexicali border crossings in both directions in 2015, and are expected to range between a low forecast of 3.8 million to a high forecast of 6.2 million trucks by 2040, with the baseline (mid-range) forecast of 4.9 million trucks in 2040.

Average payload for import truck from Mexico to California was rounded to 5,500 kg per truck based on U.S. TransBorder Freight Data for the year 2014. The average payload for export truck was assumed to be the same as the import truck. Cargo weight was converted to loaded TEUs using an average of 10 tons per TEU for both import and export truck. Therefore, in terms of loaded TEUs, 1.4 million TEUs in 2014 and 3.0 million TEUs in 2040 were estimated to cross the border. The loaded cargo at San Pedro Bay Ports, in comparison, is about 11.7 million TEUs in 2015 and 27.6 million TEUs in 2040, which means the border-crossing-related loads are much smaller compared to the port-related loads.

[19] This would rise to 3.8 percent in 2014 and 2.7 percent in 2040 if it were assumed that 100 percent of non-IPI export loads needed warehouse space.

The SCAG border-crossing study provided 2015 and 2040 origin-destination truck flows patterns between the two border crossings and 35 zones in the U.S., 33 of which are in the SCAG region, one is SANDAG and the last one is External to SCAG region. One of the zones in the SCAG region represented the San Pedro Bay Ports. The geographical zones used in the SCAG border-crossing study were different from that used in this study. Hence, the origin-destination truck flows information developed in the border-crossing study were approximately translated to 43 submarket areas. For zones in the SCAG border-crossing study that belonged to multiple submarket areas in this study, the flow was distributed among the submarket areas based on shares of existing warehousing building area in 2015, and shares of existing and developable warehouse building area in 2040. Table 3.5 shows the lookup values between the SCAG border-crossing study and submarket areas in this study.

Table 3.5 Lookup Values between Border Crossing Study Zones and Submarket Areas in this Study

Border Crossing Study Zone ID	Border Crossing Study Zone	County	Submarket Area ID	Submarket Area	County	2015	2040
1	Ports of LA/LB	Los Angeles	1	Long Beach Area Ind	Los Angeles	1.00	1.00
2	Inglewood/LAX	Los Angeles	15	El Segundo/Hawthorne Ind	Los Angeles	1.00	1.00
3	Santa Clarita/Palmdale/Lancaster	Los Angeles	29	Santa Clarita Valley Ind	Los Angeles	0.67	0.20
3	Santa Clarita/Palmdale/Lancaster	Los Angeles	39	Antelope Valley Ind	Los Angeles	0.33	0.80
3	Santa Clarita/Palmdale/Lancaster	Los Angeles	40	NW LA Cnty Outlying Ind	Los Angeles	0.00	0.00
4	Irvine	Orange	28	John Wayne Airport Area Ind	Orange	1.00	1.00
5	Santa Ana	Orange	28	John Wayne Airport Area Ind	Orange	1.00	1.00
6	Corona	Riverside	25	Corona Ind	Riverside	1.00	1.00
7	Burbank/San Fernando Valley	Los Angeles	21	SFV East Ind	Los Angeles	1.00	1.00
8	Victorville/High Desert	Los Angeles/ San Bernardino	19	North San Bernardino County Ind	San Bernardino	0.99	1.00
8	Victorville/High Desert	Los Angeles/ San Bernardino	22	East LA Cnty Outlying Ind	Los Angeles	0.00	0.00
8	Victorville/High Desert	Los Angeles/ San Bernardino	35	San Bernardino County Outlying Ind	San Bernardino	0.01	0.00
8	Victorville/High Desert	Los Angeles/ San Bernardino	38	NE LA Cnty Outlying Ind	Los Angeles	0.00	0.00
9	Downtown Los Angeles	Los Angeles	14	Central LA Ind	Los Angeles	1.00	1.00
10	Long Beach	Los Angeles/Orange	17	West Orange County Ind	Orange	0.29	0.28
10	Long Beach	Los Angeles/Orange	28	John Wayne Airport Area Ind	Orange	0.50	0.48
10	Long Beach	Los Angeles/Orange	31	South Orange County Ind	Orange	0.20	0.24
11	Indio	San Bernardino/ Riverside	24	Coachella Valley Ind	Riverside	0.99	1.00

Border Crossing Study Zone ID	Border Crossing Study Zone	County	Submarket Area ID	Submarket Area	County	2015	2040
11	Indio	San Bernardino/ Riverside	36	Riverside County Outlying Ind	Riverside	0.01	0.00
12	Whittier-1	Los Angeles	6	Commerce Area Ind	Los Angeles	1.00	1.00
13	Torrance/South Bay Cities	Los Angeles	13	Gardena/110 Corridor Ind	Los Angeles	0.48	0.50
13	Torrance/South Bay Cities	Los Angeles	34	Torrance/Beach Cities Ind	Los Angeles	0.52	0.50
14	Downey	Los Angeles	3	Lynwood/Paramount Ind	Los Angeles	1.00	1.00
15	Oxnard/Ventura	Ventura	23	Ventura County Ind	Ventura	1.00	1.00
15	Oxnard/Ventura	Ventura	41	Ventura Cnty Outlying Ind	Ventura	0.00	0.00
16	Calexico/El Centro/Brawley	Imperial	42	Imperial County Ind	Imperial	1.00	1.00
17	San Bernardino	San Bernardino	12	East San Bernardino County Ind	San Bernardino	0.42	0.32
17	San Bernardino	San Bernardino	18	Riverside Ind	Riverside	0.44	0.53
17	San Bernardino	San Bernardino	32	South Riverside County Ind	Riverside	0.14	0.15
18	Simi Valley/Malibu	Los Angeles	30	SFV West Ind	Los Angeles	0.68	0.68
18	Simi Valley/Malibu	Los Angeles	37	Conejo Valley Ind	Los Angeles	0.32	0.32
19	South Gate	Los Angeles	5	Vernon Area Ind	Los Angeles	1.00	1.00
20	Pomona/Ontario Airport	Los Angeles	9	Eastern SGV Ind	Los Angeles	0.08	0.06
20	Pomona/Ontario Airport	Los Angeles	10	West San Bernardino County Ind	San Bernardino	0.18	0.13
20	Pomona/Ontario Airport	Los Angeles	11	Ontario Airport Area Ind	San Bernardino	0.68	0.77
20	Pomona/Ontario Airport	Los Angeles	33	Upper SGV Ind	Los Angeles	0.07	0.05
21	Santa Monica/West LA	Los Angeles	20	Westside Ind	Los Angeles	1.00	1.00
22	Florence	Los Angeles	14	Central LA Ind	Los Angeles	1.00	1.00
23	Carson	Los Angeles	2	Carson/Rancho Domingz Ind	Los Angeles	1.00	1.00
24	Calipatria/Imperial County	Imperial	42	Imperial County Ind	Imperial	1.00	1.00
25	Whittier-2	Los Angeles	6	Commerce Area Ind	Los Angeles	1.00	1.00

Border Crossing Study Zone ID	Border Crossing Study Zone	County	Submarket Area ID	Submarket Area	County	2015	2040
26	Norwalk	Los Angeles	4	Mid Counties-LA Ind	Los Angeles	1.00	1.00
27	West Puente Valley	Los Angeles	7	Southwest SGV Ind	Los Angeles	1.00	1.00
28	Highland Park	Los Angeles	14	Central LA Ind	Los Angeles	1.00	1.00
29	Diamond Bar	Los Angeles	8	Lower SGV Ind	Los Angeles	1.00	1.00
30	La Canada/Flintridge	Los Angeles	21	SFV East Ind	Los Angeles	1.00	1.00
31	West Whittier-Los Nietos	Los Angeles	6	Commerce Area Ind	Los Angeles	1.00	1.00
32	El Monte	Los Angeles	26	Northwest SGV Ind	Los Angeles	1.00	1.00
33	Moreno Valley	Orange/Riverside/ San Bernardino	12	East San Bernardino County Ind	San Bernardino	0.42	0.32
33	Moreno Valley	Orange/Riverside/ San Bernardino	18	Riverside Ind	Riverside	0.44	0.53
33	Moreno Valley	Orange/Riverside/ San Bernardino	32	South Riverside County Ind	Riverside	0.14	0.15
	External			External		1.00	1.00
	SANDAG			SANDAG		1.00	1.00

Source: Cambridge Systematics, Inc.

Border-crossing-related stop assumptions were made in the warehouse space forecasting model to estimate border-crossing-related warehoused loads. The model user would be able to change these assumptions as information becomes available. The model assumed that 100 percent of import loads and 100 percent of export loads through the border crossings, and originating or terminating in the 33 zones in the SCAG region are warehoused at least one time at a GPW. The border-crossing-related loads to/from port zone (Ports of Los Angeles/Long Beach) are assumed to be included in port-related warehoused loads, and, therefore, are avoided from border-crossing-related warehoused loads. Approximately 50 percent of imported loads to external zone and zones in the SCAG region other than near border zone (Calexico/El Centro/Brawley) and port zone (Ports of Los Angeles/Long Beach) are assumed to be crossdock transloaded at crossdock transload facilities in Imperial County. About 25 percent of imported loads to external zone are assumed to be stored at a RDC in the SCAG region. Table 3.6 summarizes the border-crossing-related warehoused loads estimates.

Table 3.6 Estimated Border-Crossing-Related Warehoused Loads in Five-Year Intervals
Thousands of TEUs

Year*	Import Loads to TFs	Import Loads to RDCs	Import Loads to GPW	Export Loads to GPW
2014	42,196	81,864	310,639	244,330
2015	44,479	85,332	325,293	254,810
2020	56,515	103,409	402,127	309,484
2025	68,551	121,485	478,961	364,158
2030	80,586	139,562	555,795	418,833
2035	92,622	157,638	632,629	473,507
2040	104,658	175,715	709,462	528,182

Source: SCAG Border Crossing Study and Analysis – Phase II; Cambridge Systematics' Analysis.

Based on the SCAG region-level calculations (as described in Section 3.4 of this document), under the baseline scenario, the SCAG region-level unconstrained warehouse space for border-crossing-related import loads is about 7.9 million square feet in 2014, and reaches about 17.8 million square feet by 2040; that is, by 125 percent or at an average annualized growth rate of 3.2 percent. In terms of share of total demand for warehouse space, border-crossing-related import loads make up about 0.7 percent in 2014, and 1.0 percent by 2040. Similarly, the SCAG region-level unconstrained warehouse space for border-crossing-related export loads is about 6.5 million square feet in 2014, and reaches about 14.0 million square feet by 2040; that is, by 116 percent or at an average annualized growth rate of 3.0 percent. In terms of share of total demand for warehouse space, border-crossing export loads make up about 0.6 percent in 2014, and 0.8 percent in 2040.

Spatial Allocation Assumptions

Spatial allocation of regional total demand for warehouse space to submarket areas for warehouse space was carried out differently for the base year (2014) and forecast years (2015-2040). It also differed by cargo submarket type. Table 3.7 describes the assumptions associated with cargo submarket types by year of analysis.

Some explanations of the spatial allocation assumptions in the base year (2014) are provided as follows:

- Spatial allocation of port-related occupied crossdock transload facility space. As shown in Figure 3.9, Cambridge Systematics identified 12 of the 43 submarket areas as suited to port-related crossdock transloading operation due to their proximity to ports.

  Cambridge Systematics also developed a "dot density" map of "transload likely"[20] locations using aerial imagery data of warehouses in the SCAG region. The visual presence of both international sized or International Standards Organization (ISO) containers (20 and 40 feet length) and domestic containers (48 and 53 feet length) in the premises of warehouse facility was considered as an approximate indicator of a transload operation. Only 8 of the 12 submarket areas contained "transload likely" warehouse locations and, thus, the 2014 SCAG region-level port-related occupied crossdock transload facility space was allocated to these 8 submarket areas as a percentage shares of their total "transload likely" warehouse locations count as follows: 1) Carson/Rancho Dominguez Ind – 40.5 percent; 2) Mid Counties-LA Ind – 23.2 percent; 3) Vernon Area Ind – 3.2 percent; 4) Commerce Area Ind – 4.9 percent; 5) Lower SGV Ind – 17.6 percent; 6) Gardena/110 Corridor Ind – 1.1 percent; 7) Central LA Ind – 0.4 percent; and 8) North Orange County Ind – 9.2 percent. The total for these percentages is 100 percent.

[20] Cambridge Systematics, Inc. identified "transload likely" warehouses as those warehouse facilities that are seen in aerial images to contain both marine containers (20 feet and 40 feet in length) and domestic containers (48 feet or 53 feet in length) in their parking lots or external storage area. This was done for the Gateway Cities Council of Governments and the ports. The information was compiled by eyeballing aerial images from Google earth in the summer of 2014 and is an approximate method. The derived information is suggestive, but not confirmative of a transload warehouse operation, but is the best available data at the time of this study.

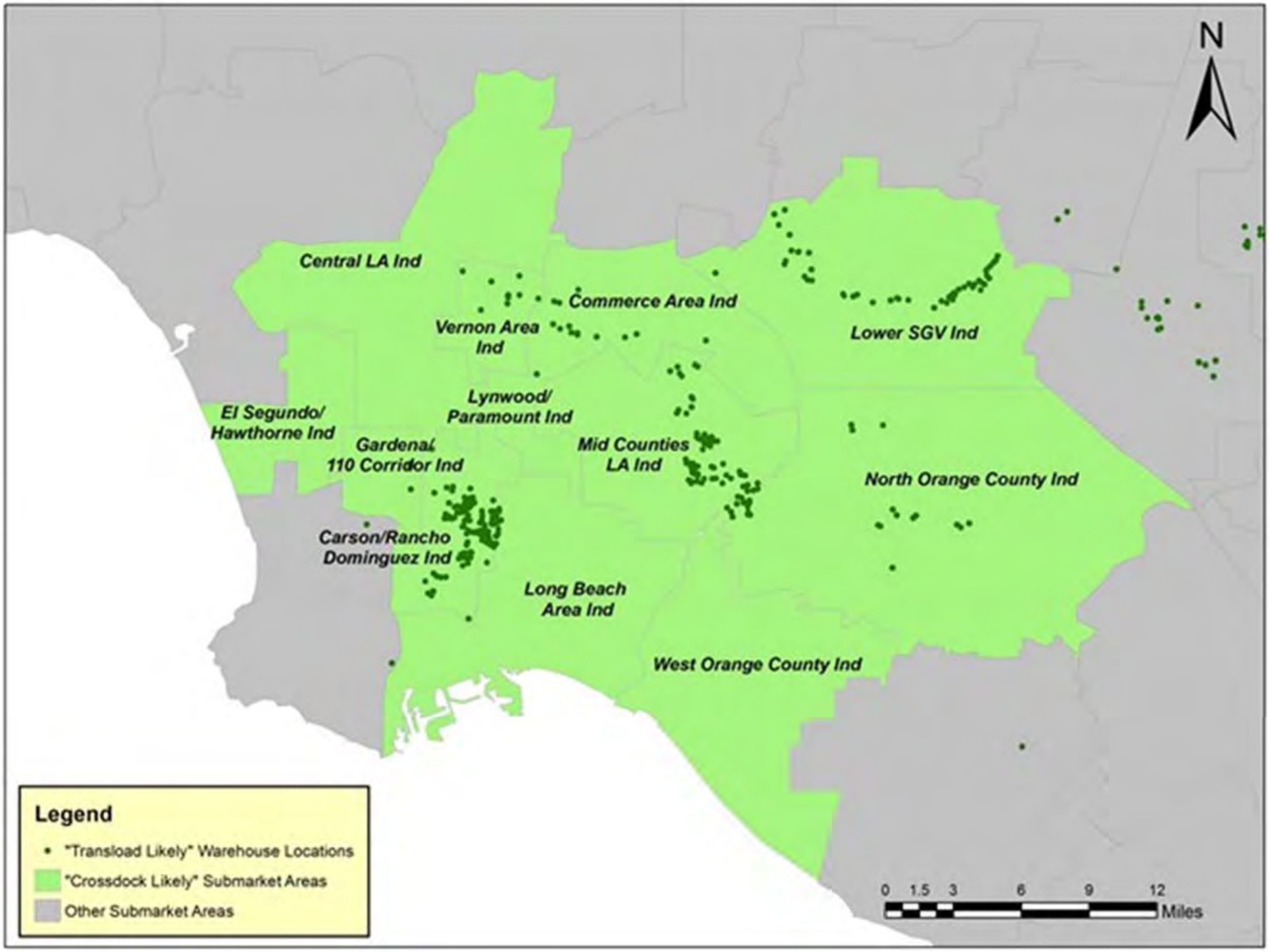
Table 3.7 Spatial Allocation Assumptions by Cargo Submarket Type and by Year of Analysis

Cargo Market/Submarket Type		Base Year Allocation Assumption	Forecast Years Allocation Assumption
Port-Related Cargo			
1	Import loads to CDFs	Among crossdock transload likely submarket areas, submarket area percentage shares of regional total counts of "transload likely" locations	Port warehousing-related priority order, but limited to crossdock transload likely submarket areas
2	Import loads to small RDCs (< 500,000 sq. ft.)	Cargo submarket percentage share of regional total small RDCs space applied to existing submarket area-level small RDC space	Historical (2004-2014) change in occupied RDC space-based priority order for vacant space allocation, and historical change in total occupied warehouse space plus developable space-based priority order for developable space allocation
3	Import loads to mega-RDCs (>= 500,000 sq. ft.)	Cargo submarket percentage share of regional total mega-RDCs space applied to existing submarket area-level mega-RDC space	
4	Import loads to import warehouses (also GPWs)	Submarket area percentage shares of regional total port-related warehouse space derived using Fratar method and 2013 SCAG Comprehensive Regional Goods Movement Plan and Implementation Strategy (CRGMPIS)-based initial shares	Port warehousing-related priority order
5	Export loads to export warehouses (also GPWs)	Submarket area percentage shares of regional total port-related warehouse space derived using Fratar method and 2013 SCAG CRGMPIS-based initial shares	Port warehousing-related priority order
Border-Crossing Related			
6	Import loads to crossdock transload facilities (TFs)	Allocated only to Imperial County industrial area	Allocated only to Imperial County industrial area
7	Import loads to small RDCs (< 500,000 sq. ft.)	Cargo submarket percentage share of regional total small RDCs space applied to existing submarket area-level small RDC space	Historical (2004-2014) change in occupied RDC space-based priority order for vacant space allocation, and historical change in total occupied warehouse space plus developable space-based priority order for developable space allocation
8	Import loads to mega-RDCs (>= 500,000 sq. ft.)	Cargo submarket percentage share of regional total mega-RDCs space applied to existing submarket area-level mega-RDC space	
9	Import loads to import warehouses (also GPWs)	As per origin-destination truck flows information for border-crossing imports in base year	As per origin-destination truck flows information for border-crossing imports in forecast years

Cargo Market/Submarket Type		Base Year Allocation Assumption	Forecast Years Allocation Assumption
10	Export loads to export warehouses (also GPWs)	As per origin-destination truck flows information for border-crossing exports in base year	As per origin-destination truck flows information for border-crossing exports in forecast years
Domestic			
11	Domestic loads to small RDCs (< 500,000 sq. ft.)	Cargo submarket percentage share of regional total small RDCs space applied to existing submarket area-level small RDC space	Historical (2004-2014) change in occupied RDC space-based priority order for vacant space allocation, and historical change in total occupied warehouse space plus developable space-based priority order for developable space allocation
12	Domestic loads to mega-RDCs (>= 500,000 sq. ft.)	Cargo submarket percentage share of regional total mega-RDCs space applied to existing submarket area-level mega-RDC space	
13	Domestic loads to GPWs	Submarket area percentage shares of regional total domestic warehouse space derived using Fratar method and 2013 SCAG CRGMPIS based initial shares	Historical (2004-2014) change in occupied GPW space-based priority order for vacant space allocation, and historical change in total occupied warehouse space plus developable space-based priority order for developable space allocation

Source: Cambridge Systematics, Inc.

Figure 3.9 "Crossdock Transload Likely" Submarket Areas and "Transload Likely" Warehouse Locations



Sources: CoStar Property® Data – Submarket Area Maps; ESRI's GIS data layers; Cambridge Systematics' Development of Submarket Area GIS data layer, March 2015; and Cambridge Systematics' Analysis of Google Earth based Aerial Imagery Data, May 2013.

- Spatial allocation of occupied RDC space. Cargo from different cargo submarket types occupy RDCs space, and they occupy both small RDCs and mega-RDCs. At both SCAG region level and submarket area level, occupied small RDC space and occupied mega-RDC space were available from CoStar Property® database in 2014. Within each type of RDC space in 2014, the percentage shares of cargo market types, namely, port-related, border-crossing-related and domestic at submarket area level were kept the same as the SCAG region-level percentage shares.
- Spatial allocation of border-crossing-related occupied crossdock transload facility space. The assumption was simple for this cargo submarket type, 100 percent of the border-crossing-related demand for crossdock transload facility space in 2014 was limited to Imperial County industrial area. The demand included only the import flows from Mexicali, as the import flows from Tijuana are likely to use San Diego industrial area for crossdock transloading of cargo. Crossdock transloading was limited to Imperial County industrial area because it is the closest to Mexicali border crossing.
- Spatial allocation of port-related and domestic occupied general purpose warehouse space. Dr. Husing and Cambridge Systematics' warehousing analysis for the 2013 SCAG CRGMPIS developed port and nonport share factors to allocate SCAG region-level port-related and nonport-related warehouse space to 25 analysis zones. In general, these share factors ensured a logical allocation of warehousing demand, including proximity to ports for port-related warehousing demand, and a higher share in allocation of nonport-related warehousing demand to industrial clusters of Los Angeles and Inland Empire region, etc. Therefore, starting from this, new port and nonport share factors were derived in this study to allocate SCAG region occupied general purpose warehouse space for port-related and domestic uses to 43 submarket areas. It was done as follows:
  - Used the 2013 warehouse analysis port and nonport share factors as seed values, but expanded them from 25 to 43 submarket areas;
  - Used the total occupied general warehouse space by submarket area, region-level port-related and nonport-related (cargo markets) occupied general warehouse space as control totals;
  - Applied Fratar method[21] and Microsoft Excel optimization tool to iteratively converge to control totals both by submarket area and cargo market type.

Table 3.8 shows the percentage shares that were used to allocate SCAG region-level port-related occupied import and export warehouse space and domestic occupied general purpose warehouse space to 43 submarket areas.

[21] This is a trip distribution method used in the field of transportation engineering. The method determines a matrix of values that simultaneously satisfy current row and column control totals. An initial balanced matrix of values is available for previous row and column control totals. Over multiple iterations, the values in the initial balanced matrix are adjusted till the current row and column control totals are approximately met. In the context of this study, the row totals refer to regional total for port-related and domestic GPW space, while the column totals refer to total GPW space in a submarket area. Also, in the context of this study, initial balanced matrix is drawn from the 2013 SCAG CRGMPIS.

Table 3.8 2014 Port-Related and Domestic Percentage Shares for GPW Space by Submarket Area in the SCAG Region

Submarket Area	Percentage Share of Total Port-Related Occupied GPW Space	Percentage Share of Total Domestic-Related Occupied GPW Space
Long Beach Area Ind	13.8%	0.1%
Carson/Rancho Domingz Ind	24.8%	2.2%
Lynwood/Paramount Ind	0.8%	0.7%
Mid Counties-LA Ind	6.5%	5.1%
Vernon Area Ind	6.2%	4.9%
Commerce Area Ind	5.8%	4.6%
Southwest SGV Ind	0.9%	0.7%
Lower SGV Ind	7.1%	5.6%
Eastern SGV Ind	2.2%	1.8%
West San Bernardino County Ind	4.5%	3.6%
Ontario Airport Area Ind	4.0%	13.7%
East San Bernardino County Ind	1.0%	3.4%
Gardena/110 Corridor Ind	2.6%	2.0%
Central LA Ind	7.0%	5.5%
El Segundo/Hawthorne Ind	0.3%	1.0%
North Orange County Ind	7.9%	6.2%
West Orange County Ind	1.3%	2.1%
Riverside Ind	1.1%	5.1%
North San Bernardino County Ind	0.0%	0.9%
Westside Ind	0.0%	0.8%
SFV East Ind	0.0%	6.6%
East LA Cnty Outlying Ind	0.0%	0.0%
Ventura County Ind	0.0%	3.0%
Coachella Valley Ind	0.0%	0.8%
Corona Ind	0.0%	1.9%
Northwest SGV Ind	0.0%	1.3%
Orange County Outlying Ind	0.0%	0.0%
John Wayne Airport Area Ind	0.0%	3.9%
SCV/Lancaster/Palmdale Ind	0.0%	1.2%
SFV West Ind	0.0%	2.4%

Submarket Area	Percentage Share of Total Port-Related Occupied GPW Space	Percentage Share of Total Domestic-Related Occupied GPW Space
South Orange County Ind	0.0%	1.5%
South Riverside County Ind	0.0%	1.7%
Upper SGV Ind	0.0%	1.9%
Torrance/Beach Cities Ind	2.2%	1.8%
San Bernardino County Outlying Ind	0.0%	0.0%
Riverside County Outlying Ind	0.0%	0.0%
Conejo Valley Ind	0.0%	1.1%
NE LA Cnty Outlying Ind	0.0%	0.0%
Antelope Valley Ind	0.0%	0.5%
NW LA Cnty Outlying Ind	0.0%	0.0%
Ventura Cnty Outlying Ind	0.0%	0.0%
Imperial County Ind	0.0%	0.0%
Catalina Island Ind	0.0%	0.0%
Total	100.0%	100.0%

Source: Derived from unpublished analysis by Dr. John Husing and Cambridge Systematics conducted for the 2013 SCAG Comprehensive Goods Movement Plan and Implementation Strategy.

- Spatial allocation of border-crossing-related occupied GPW space. The assumption for this cargo submarket type was based on the data provided by the ongoing SCAG Goods Movement Border Crossing Study and Analysis – Phase II. Border-crossings-related origin-destination truck flows distribution for 2015 and 2040 (see Table 3.9) was extrapolated to the year 2014. The estimated distribution for 2014 was used to allocate SCAG region-level border-crossing-related occupied GWP space (for imports/exports) to the submarket areas. Under the baseline scenario of the warehouse space forecast model, border-crossing-related baseline scenario information was used.

Table 3.9 Baseline Scenario Border-Crossing-Related Origin-Destination Truck Flows Distribution, 2015 and 2040

Border Crossing Study Zone ID	Border Crossing Study Zone	County(s)	Tijuana Border-Crossing-Related Truck Volume Distribution				Mexicali Border-Crossing-Related Truck Volume Distribution			
			2015		2040		2015		2040	
			N/B	S/B	N/B	S/B	N/B	S/B	N/B	S/B
1	Ports of Los Angeles/Long Beach	Los Angeles								
2	Inglewood/Los Angeles International Airport (LAX)	Los Angeles	5.5%	2.5%	5.5%	2.5%	0.0%	0.0%	0.0%	0.0%
3	Santa Clarita/Palmdale/Lancaster	Los Angeles	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
4	Irvine	Orange	5.8%	11.1%	5.8%	11.1%	0.0%	0.0%	0.0%	0.0%
5	Santa Ana	Orange	1.1%	2.4%	1.1%	2.4%	0.0%	0.2%	0.0%	0.2%
6	Corona	Riverside	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
7	Burbank/San Fernando Valley	Los Angeles	0.1%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
8	Victorville/High Desert	Los Angeles/ San Bernardino	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
9	Downtown Los Angeles	Los Angeles	2.0%	0.7%	2.0%	0.7%	0.1%	0.0%	0.1%	0.0%
10	Long Beach	Los Angeles/Orange	7.2%	3.6%	7.2%	3.6%	0.1%	0.0%	0.1%	0.0%
11	Indio	San Bernardino/ Riverside	0.0%	0.1%	0.0%	0.1%	0.3%	0.0%	0.3%	0.0%
12	Whittier-1	Los Angeles	0.0%	0.1%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%
13	Torrance/South Bay Cities	Los Angeles	0.0%	0.0%	0.0%	0.0%	4.1%	0.0%	4.1%	0.0%
14	Downey	Los Angeles	3.0%	3.5%	3.0%	3.5%	0.0%	0.0%	0.0%	0.0%
15	Oxnard/Ventura	Ventura	0.0%	0.0%	0.0%	0.0%	14.3%	5.9%	14.3%	5.9%
16	Calexico/El Centro/Brawley	Imperial	0.0%	0.9%	0.0%	0.9%	54.7%	19.2%	54.7%	19.2%

Border Crossing Study Zone ID	Border Crossing Study Zone	County(s)	Tijuana Border-Crossing-Related Truck Volume Distribution				Mexicali Border-Crossing-Related Truck Volume Distribution			
			2015		2040		2015		2040	
			N/B	S/B	N/B	S/B	N/B	S/B	N/B	S/B
17	San Bernardino	San Bernardino	0.2%	0.0%	0.2%	0.0%	0.0%	2.9%	0.0%	2.9%
18	Simi Valley/Malibu	Los Angeles	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
19	South Gate	Los Angeles	0.3%	1.9%	0.3%	1.9%	0.2%	0.0%	0.2%	0.0%
20	Pomona/Ontario Airport	Los Angeles	0.0%	2.0%	0.0%	2.0%	0.0%	0.2%	0.0%	0.2%
21	Santa Monica/West LA	Los Angeles	0.0%	0.6%	0.0%	0.6%	20.1%	0.4%	20.1%	0.4%
22	Florence	Los Angeles	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.1%	0.0%
23	Carson	Los Angeles	1.6%	8.2%	1.6%	8.2%	0.0%	0.0%	0.0%	0.0%
24	Calipatria/Imperial County	Imperial	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
25	Whittier-2	Los Angeles	0.0%	0.0%	0.0%	0.0%	0.0%	1.2%	0.0%	1.2%
26	Norwalk	Los Angeles	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
27	West Puente Valley	Los Angeles	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
28	Highland Park	Los Angeles	0.0%	0.2%	0.0%	0.2%	0.0%	0.6%	0.0%	0.6%
29	Diamond Bar	Los Angeles	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
30	La Canada/Flintridge	Los Angeles	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
31	West Whittier-Los Nietos	Los Angeles	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
32	El Monte	Los Angeles	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
33	Moreno Valley	Orange/Riverside/ San Bernardino	0.0%	0.7%	0.0%	0.7%	0.0%	0.0%	0.0%	0.0%
External			21.2%	25.8%	21.2%	25.8%	6.0%	65.3%	6.0%	65.3%
San Diego Association of Governments (SANDAG)			52.0%	35.9%	52.0%	35.9%	0.1%	4.3%	0.1%	4.3%
Total			100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: SCAG Goods Movement Border Crossing Study and Analysis – Phase II (Not Published Yet).

Note: N/B = Northbound (or Imports), S/B = Southbound (or Exports).

Some explanations of the spatial allocation assumptions in the forecast years (2015-2040) are provided as follows:

- Spatial allocation of port-related occupied crossdock transload facility space. The SCAG region-level port-related occupied crossdock transload facility space in forecast years was allocated to all 12 submarket areas that Cambridge Systematics identified as "crossdock transload likely" submarket areas and assumed the following port-related order of priority: 1) Long Beach Area Ind; 2) Carson/Rancho Dominguez Ind; 3) Lynwood/Paramount Ind; 4) Mid-Counties-LA Ind; 5) Vernon Area Ind; 6) Commerce Area Ind; 7) Lower SGV Ind; 8) Gardena/110 Corridor Ind; 9) Central LA Ind; 10) El Segundo/Hawthorne Ind; 11) North Orange County Ind; and 12) West Orange County Ind.
- Spatial allocation of occupied RDC space to available vacant RDC space. For cargo from different cargo submarket occupying RDCs space and both small RDCs and mega=RDCs, the assumptions were kept similar. For added demand of warehouse space that can be allocated within available vacant warehouse space, historical change (2004-2014) in occupied RDC space was used to identify a priority order for submarket areas (see Table 3.10). The historical change is indicative of the industry preferences and decision-making factors in selection of submarket areas, such as cost of leasing/ development, proximity to markets/customers, ease of access, warehouse building quality, availability of cargo-related services, etc.
- Spatial allocation of domestic occupied GPW space to available vacant GPW space. For added demand of domestic GPW space that can be allocated within available vacant warehouse space, using a similar approach as the RDC space, but with historical (2004-2014) change in occupied GPW space, a priority order for submarket areas was determined (see Table 3.10).
- Spatial allocation of occupied RDC space and domestic occupied GPW space to available developable warehouse space. For added demand of warehouse space, under the categories of RDC and domestic GPW, which cannot be allocated within available vacant warehouse space, but can be allocated within available developable warehouse space, the developable warehouse space was added to historical change (2004-2014) in total occupied warehouse space to identify a priority order for submarket areas (see Table 3.12).
- Spatial allocation of border-crossing-related occupied crossdock transload facility space. Similar to the base year (2014) spatial allocation, 100 percent of the border-crossing-related demand for crossdock transload facility space in forecast years was allocated to Imperial County industrial area.
- Spatial allocation of port-related GPW space. Based on the priority order for 25 zones for port-related warehouses in the 2013 SCAG CRGMPIS, a priority order for 43 submarket areas for port-related GPW space was derived as shown in Table 3.13.

Table 3.10 Priority Order for Spatial Allocation of Region-Level Occupied RDC Space to Available Vacant RDC Space in Submarket Areas

Priority Number	Submarket Area	Historical Change in Occupied RDC Space (Square Feet)
1	East San Bernardino County Ind	34,310,916
2	Riverside Ind	19,542,740
3	Ontario Airport Area Ind	12,510,617
4	West San Bernardino County Ind	4,495,857
5	South Riverside County Ind	4,336,222
6	Lower SGV Ind	3,535,950
7	Mid Counties-LA Ind	2,653,666
8	SFV East Ind	895,652
9	North Orange County Ind	762,729
10	Commerce Area Ind	698,816
11	North San Bernardino County Ind	657,673
12	West Orange County Ind	627,927
13	Lynwood/Paramount Ind	551,897
14	Torrance/Beach Cities Ind	486,696
15	Carson/Rancho Domingz Ind	457,016
16	El Segundo/Hawthorne Ind	380,946
17	Imperial County Ind	305,725
18	Santa Clarita Valley Ind	243,853
19	Corona Ind	220,775
20	Eastern SGV Ind	202,803
21	Ventura County Ind	101,504
22	SFV West Ind	92,778
23	Coachella Valley Ind	46,847
24	Central LA Ind	34,354

Source: CoStar Property® Historical (2004-2014) Year-End Data.

Table 3.11 Priority Order for Spatial Allocation of Region-Level Domestic Occupied GPW Space to Available Vacant GPW Space in Submarket Areas

Priority Number	Submarket Area	Historical Change in Occupied GPW Space (Square Feet)
1	Ontario Airport Area Ind	19,833,030
2	Riverside Ind	15,446,627
3	East San Bernardino County Ind	11,303,731
4	West San Bernardino County Ind	5,656,583
5	Lower SGV Ind	3,327,588
6	South Riverside County Ind	3,237,871
7	Corona Ind	2,331,533
8	North San Bernardino County Ind	2,033,804
9	Carson/Rancho Domingz Ind	1,768,269
10	Mid Counties-LA Ind	1,584,049
11	Imperial County Ind	1,192,826
12	Coachella Valley Ind	1,133,277
13	Antelope Valley Ind	1,021,942
14	Gardena/110 Corridor Ind	870,585
15	Eastern SGV Ind	868,102
16	Long Beach Area Ind	627,674
17	Upper SGV Ind	592,600
18	Torrance/Beach Cities Ind	532,504
19	Ventura County Ind	398,961
20	El Segundo/Hawthorne Ind	342,384
21	Santa Clarita Valley Ind	330,958
22	SFV West Ind	218,023
23	Conejo Valley Ind	207,354
24	Southwest SGV Ind	46,470
25	Orange County Outlying Ind	38,900
26	Commerce Area Ind	6,620

Source: CoStar Property® Historical (2004-2014) Year-End Data.

Table 3.12 Priority Order for Spatial Allocation of Region-Level Occupied RDC Space and Domestic Occupied GPW Space to Available Developable Warehouse Space in Submarket Areas

Priority #	Submarket Area	Historical Change in Total Occupied Warehouse Space + Developable Space (Square Feet)
1	Ontario Airport Area Ind	125,541,081
2	Riverside Ind	82,277,887
3	East San Bernardino County Ind	45,614,647
4	Antelope Valley Ind	43,005,678
5	Lower SGV Ind	31,453,291
6	North San Bernardino County Ind	28,695,490
7	Coachella Valley Ind	25,535,961
8	South Riverside County Ind	18,758,507
9	Carson/Rancho Domingz Ind	10,797,015
10	Vernon Area Ind	10,629,777
11	Central LA Ind	10,302,040
12	West San Bernardino County Ind	10,152,440
13	Long Beach Area Ind	7,572,683
14	Mid Counties-LA Ind	6,697,394
15	Ventura County Ind	5,100,837
16	Gardena/110 Corridor Ind	4,250,469
17	North Orange County Ind	4,236,611
18	SFV West Ind	4,236,237
19	South Orange County Ind	3,548,411
20	Corona Ind	3,298,361
21	Torrance/Beach Cities Ind	2,507,101
22	Commerce Area Ind	2,386,500
23	Conejo Valley Ind	2,320,195
24	Imperial County Ind	1,498,551
25	El Segundo/Hawthorne Ind	1,309,932
26	Eastern SGV Ind	1,070,905
27	SFV East Ind	704,151
28	Santa Clarita Valley Ind	574,811
29	Upper SGV Ind	545,790
30	West Orange County Ind	395,410
31	Southwest SGV Ind	46,470
32	Orange County Outlying Ind	38,900

Source: CoStar Property® Historical (2004-2014) Year-End Data.

Table 3.13 Priority Order for Spatial Allocation of Region-Level Port-Related Occupied GPW Space to Submarket Areas

Priority Number	Submarket Area	Priority Number	Submarket Area
1	Long Beach Area Ind	23	Ventura County Ind
2	Carson/Rancho Domingz Ind	24	Coachella Valley Ind
3	Lynwood/Paramount Ind	25	Corona Ind
4	Mid Counties-LA Ind	26	Northwest SGV Ind
5	Vernon Area Ind	27	Orange County Outlying Ind
6	Commerce Area Ind	28	John Wayne Airport Area Ind
7	Southwest SGV Ind	29	Santa Clarita Valley Ind
8	Lower SGV Ind	30	SFV West Ind
9	Eastern SGV Ind	31	South Orange County Ind
10	West San Bernardino County Ind	32	South Riverside County Ind
11	Ontario Airport Area Ind	33	Upper SGV Ind
12	East San Bernardino County Ind	34	Torrance/Beach Cities Ind
13	Gardena/110 Corridor Ind	35	San Bernardino County Outlying Ind
14	Central LA Ind	36	Riverside County Outlying Ind
15	El Segundo/Hawthorne Ind	37	Conejo Valley Ind
16	North Orange County Ind	38	NE LA Cnty Outlying Ind
17	West Orange County Ind	39	Antelope Valley Ind
18	Riverside Ind	40	NW LA Cnty Outlying Ind
19	North San Bernardino County Ind	41	Ventura Cnty Outlying Ind
20	Westside Ind	42	Imperial County Ind
21	SFV East Ind	43	Catalina Island Ind
22	East LA Cnty Outlying Ind		

Source: CoStar Property® Historical (2004-2014) Year-End Data.

- Spatial allocation of border-crossing-related occupied GPW space. Similar to the base year (2014) spatial allocation, border-crossings-related origin-destination truck flows distribution for 2015 and 2040 (see Table 3.9) was interpolated to the forecast years. The estimated distribution for the forecast years was used to allocate SCAG region-level border-crossing-related occupied GPW space (for imports/exports) to the submarket areas.

  A special consideration was placed on Imperial County industrial area due to its strategic location near Mexicali border-crossing and low development costs, and is not anticipated to be capacity constrained in terms of border-crossing-related demand for GPW space. New developable space is expected to be added in Imperial County in response to the future border-crossing-related demand.

Under the baseline scenario of the warehouse space forecast model, border-crossing-related baseline scenario information was used.

Scenarios Inputs

The 10 general inputs that are available to user to run the baseline scenario are as follows:

1. Select a scenario. This is a dropdown option where user can select one among the nine available scenarios, which are: a) Baseline Scenario (also referred sometimes as Alt. Scenario 0); b) Alt. Scenario 1: Baseline Scenario Plus Efficiency Gain; c) Alt. Scenario 2: Baseline Scenario Plus Efficiency Gain Plus Replacement of Obsolete Buildings; d) Alt. Scenario 3: Baseline Scenario Plus Efficiency Gain Plus Increased Mega RDCs Share; e) Alt. Scenario 4: Baseline Scenario Plus Efficiency Gain Plus Increased Crossdock Transloading Share; f) Alt. Scenario 5: Baseline Scenario Plus Efficiency Gain Plus Increased E-commerce and Fulfillment Centers Share; g) Alt. Scenario 6: Baseline Scenario Plus Efficiency Gain Plus Lower Border-Crossing Growth Scenario; h) Alt. Scenario 7: Baseline Scenario Plus Efficiency Gain Plus Higher Border-Crossing Growth Scenario; and i) Alt. Scenario 8: Baseline Scenario Plus Efficiency Gain Plus Increased Developable Space. Definitions and descriptions of the alternate scenarios will be in Task 5 technical memorandum. The default option is (a).
2. Select growth forecast method for warehoused loads. This is a dropdown option where user can select one among the two options, which are: a) Proportional to U.S. GDP Forecast; and b) Proportional to Projected SCAG Region Occupied Warehouse Space under No Efficiency Gain in Cargo Storage. This was explained earlier in this section in the context of U.S. GDP-based growth factors. The default option is (b).
3. Select minimum vacancy percentage. This is a dropdown option with low percentage values ranging from 0 percent to 2.5 percent, at intervals of 0.5 percent. It provides flexibility with the extent to which vacant warehouse space and developable warehouse space are available for tenant occupation. The default value is 1 percent.
4. Mega-RDC definition (minimum square feet). This is a dropdown option with three values: a) 500,000 square feet; b) 750,000 square feet; and c) 1,000,000 square feet. It provides flexibility with the manner in which mega-RDC is defined. The default value is 500,000 square feet.
5. Obsolete building definition. For each decade of analysis (up to 2020, 2021-2030, and 2031-2040), a historical building era (era in which a warehouse building was constructed or last renovated) can be selected as obsolete warehouse buildings stock for that decade of analysis. The options for up to 2020 decade of analysis are:
    a. Pre-1945, pre-1970, and pre-1980 building eras;
    b. For 2021-2030 decade of analysis, these are: pre-1970, pre-1980, and pre-1990 building eras; and

c. For 2031-2040 decade of analysis, these are: pre-1980, pre-1990, and pre-2000.

Mid-range values are default inputs. This input helps identify percentage of obsolete warehouse buildings stock in existing warehouse space inventory.

This input works in tandem with Scenarios Input #16 (a *scenario specific input*); namely, *Percentage Obsolete Buildings Replaced by Era*, which is active only under *Alt. Scenario 2: Baseline Scenario Plus Efficiency Gain Plus Replacement of Obsolete Buildings*.

6. Existing Developments Average Efficiency Parameters by Cargo Submarket. This is a set of four parameters (u_1, u_2, t, and h) within Avison-Young formula, for each cargo submarket type which characterize average cargo storage efficiency for existing warehouse inventory. They form a key basis for the formula (as described in Section 3.3 of this document) for converting existing warehoused loads in the base year to equivalent warehouse space values. Under the baseline scenario, the same parameters are applied to added warehoused loads in the forecast years.

   The parameter values for this input were assumed as follows:

   a. d, e, u_1, u_2 are assumed to be constant value of 1,328.64 cubic feet per TEU, 0.9, 0.225, or 22.5 percent and 0.75 or 75 percent, respectively.[22]

   b. t is assumed to be 300 for crossdock transload facility; 12 for other functional use types of warehouse buildings, except Imperial County where turnover rate of 36 was assumed.[23]

   c. Roughly based on the average height in the 2014 CoStar inventory, h is assumed to vary for different functional use types of warehouse building as follows: i) crossdock facility – 8 feet; ii) GPW – 22 feet; iii) small RDC – 27 feet; and d) mega-RDC – 30 feet.

7. Replaced/New Developments Average Efficiency Parameters by Cargo Submarket. This input is similar to Scenarios Input #6, except that the set of parameters would result in a higher average cargo storage efficiency and the parameters are applicable only on: a) existing warehoused loads when warehouse facilities handling them have become obsolete and, thus, are replaced, or b) added warehoused loads in the forecast years that are handled by new developments, or c) both a) and (b). Under the baseline scenario, however, these parameters are not applied.

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[22] Ranges for u_1 and u_2 variables were discussed in Section 1.0. Physical characteristics inside the building determine the "theoretical storage capacity" for a warehouse, which can typically range between 22 to 27 percent of the building's cubic capacity. Based on an average value for Watson Land Company's warehouses, 22.5 percent was selected. Utilization of the warehouse theoretical storage capacity, or "working storage capacity," generally ranges between 60 to 90 percent of the theoretical storage capacity. As a reasonable mid-range value, 75 percent was chosen.

[23] A CDF is functionally used to provide one-day turnaround of cargo, while a GPW is functionally used for a longer-term storage, cargo is assumed to be on average 30 days in inventory before moving them to a wholesale or retail store for sale. Due to a limited supply of GPWs in Imperial County and comparatively high border-crossing loads, a higher turnover rate was assumed for this industrial area. Hence, the turnover rates of 300, 12, and 36 turns per year are used.

The input works in tandem with Scenarios Input #17 (a *scenario specific input*, discussed in the Task 5 report); namely, *Apply Efficiency Gain due to Automation and Use of Better Technology*, which specifies which cargo submarkets would undergo efficiency gain; and which type of developments, replaced or new developments or both, would undergo efficiency gain. Under all scenarios, except baseline scenario, these parameters are applied on new developments; and only under *Alt. Scenario 2: Baseline Scenario Plus Efficiency Gain Plus Replacement of Obsolete Buildings*. These parameters also are applied on replaced developments.

The parameter values for this input were assumed as follows:

a. u_1 is assumed to be 0.25 or 25.0 percent for all new warehouse developments; and u_2 is assumed to be 0.8 or 80 percent for crossdock transload facilities and fulfillment center type mega-RDCs.

b. The average height, h, for new developments is assumed to vary by different functional use types of warehouse building, as follows: i) general purpose warehouse – 25 feet; ii) small RDC – 35 feet; and c) mega-RDC – 45 feet.

By applying the above parameter values, there would be efficiency gains in different functional use types of warehouse buildings, which are expected to range between 19 percent and 78 percent increase in average efficiency. Due to the presence of a mix of existing, replaced and new developments, the average efficiency gains in a forecast year would be smaller than these percentages, but would be constantly improving as the share of replaced/new developments increases.

8. San Pedro Bay Ports-Related Warehouse Stops Assumptions. This input represents the percentages of port-related non-IPI import loads and port-related non-IPI export loads that are warehoused. These were already explained in the context of *San Pedro Bay Ports Containerized Cargo Forecasts and Port-Related Truck Based Cargo Stops Information*.

9. Border-Crossing-Related Flow Assumptions. This input represents the factors for conversion of truck flows to TEUs for border-crossing-related cargo. These were already explained in the context of *Border-Crossing Freight Flow Forecasts and Stops Information*.

10. Border-Crossing-Related Warehouse Stops Assumptions. This input represents the percentages of border-crossing-related import loads and border-crossing-related export loads that are warehoused. These were already explained in the context of *Border-Crossing Freight Flow Forecasts and Stops Information*.

The remaining eight scenario-specific inputs will be discussed in Task 5 report.

3.3 Details on Model Calculations for Baseline Scenario

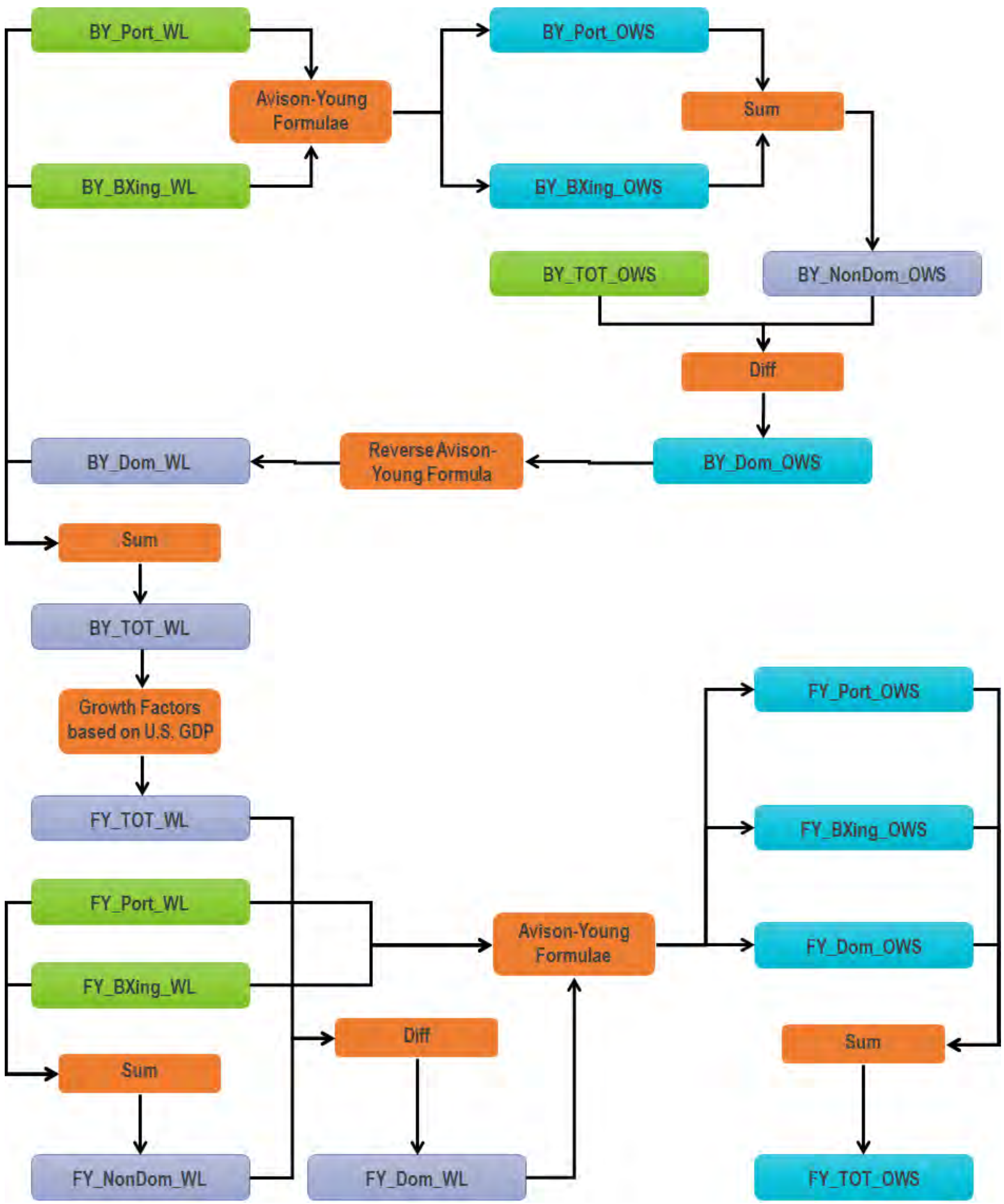
The model uses a two-stage process for estimating demand for warehouse space. In the first stage, the model estimates *unconstrained* SCAG region-level occupied warehouse space for all cargo submarket types. In the second stage, the model allocates the demand to 43 submarket areas, while considering constraints of available vacant warehouse space and available developable warehouse space in each submarket area.

Unconstrained SCAG Region-Level Warehouse Space Forecasting

Figure 3.10 shows a flowchart for the first stage of the model calculations, which are carried at SCAG region level. Although, the flowchart is showing cargo market, the mathematical operations are still performed at the level of cargo submarket type. For example, when base year port-related warehoused loads are converted to base year port-related warehouse space using Avison-Young formula, the actual mathematical operation is performed on each of the five cargo submarket types under port-related cargo market. Each cargo submarket type uses its own Avison-Young parameters, and so on.

The calculations use estimated inputs at SCAG region-level (expressed in green cells in Figure 3.10); namely, base year port-related warehoused loads (BY_Port_WL) in TEUs, base year border-crossing warehoused loads (BY_BXing_WL) in TEUs, base year total occupied warehousing space (BY_TOT_OWS) in square feet, forecast year port-related warehoused loads (FY_Port_WL) in TEUs, forecast year border-crossing-related warehoused loads (FY_BXing_WL) in TEUs, and estimated growth factors based on U.S. GDP. In addition, the calculations use relevant parameters in Avison-Young formula (as shown below) for existing cargo in the base year and added cargo in forecast years.

Figure 3.10 Algorithm for Region-Level Unconstrained Warehouse Space Forecasting



Source: Cambridge Systematics, Inc.

Key: WL – Warehoused Loads in TEUs, OWS – Occupied Warehouse Space in square feet, BY – Base Year, FY – Forecast Year, Green cells – Inputs, Blue cells – Outputs, Purple cells – Intermediate Values, Orange cells – mathematical operation, Port – Port-related cargo market, BXing – Border-crossing-related cargo market, Dom – Domestic cargo market, and NonDom – Nondomestic cargo market (Port plus Border-Crossing related).

$$W = L * d * e * (1/(u_1 * u_2 * t * h))$$

Where:

W = *Warehouse space needed (in square feet) to accommodate container volumes by cargo submarket type;*

L = *Warehoused Loads in TEUs per year by cargo submarket type;*

d = *Weighted average cargo capacity of TEU (in cubic feet) (constant value assumed = 1,329 cubic feet per TEU*[24]*);*

e = *Efficiency of container (i.e., percent of container filled with cargo, constant value assumed = 90 percent*[25]*);*

u1 = *Warehouse cubic space utilization ratio and used for cargo at full capacity by cargo submarket type, as per scenarios input;*

u2 = *Average percentage capacity utilization annually by cargo submarket type, as per scenarios input;*

t = *Turnover rate (in turns per year) of cargo in warehouse by cargo submarket type, as per scenarios input; and*

h = *Ceiling height (in feet) used for cargo storage by cargo submarket type, as per scenarios input.*

Figure 3.10 shows that the calculation steps are as follows:

1. Convert BY_Port_WL and BY_BXing_WL to their occupied warehouse space equivalent values (BY_Port_OWS and BY_BXing_OWS) using Avison-Young formula.
2. Add the results in 1) and subtract from BY_TOT_OWS to estimate SCAG region-level domestic-related occupied warehouse space (BY_Dom_OWS).
3. Apply Avison-Young formula in reverse direction to convert result in 2) to warehoused load equivalent value (BY_Dom_WL).
4. Add BY_Port_WL, BY_BXing_WL and BY_Dom_WL to get SCAG region-level total warehoused loads (BY_TOT_WL).
5. Apply growth factors based on U.S. GDP on result in 4) to estimate forecasts of SCAG region-level total warehoused loads (FY_TOT_WL).
6. Subtract the sum of FY_Port_WL and FY_BXing_WL from FY_TOT_WL to estimate forecasts of SCAG region-level domestic warehoused loads (FY_Dom_WL).
7. Apply Avison-Young formula to convert result in Step 6 to occupied warehouse space equivalent value (FY_Dom_OWS).

[24] Based on the assumption of 81.11 percent high-cube 40-foot container with 2,694 cubic feet per TEU, and 18.89 percent 20-foot container with 1,171 cubic feet per TEU.

[25] 90 percent are a reasonable assumption; in that, containers can only be filled to 100 percent of capacity if the package sizes are exactly designed with container dimensions in mind.

8. Add FY_Port_OWS, FY_BXing_ OWS and FY_Dom_ OWS to get SCAG region-level total occupied warehouse space (FY_TOT_ OWS).

At the end of the first stage of calculations, we have SCAG region-level warehoused loads and occupied warehouse space for all cargo submarket types. The calculations do not use information on the submarket area-level availability of vacant or developable warehouse space; hence, the warehouse space forecasts by cargo submarket type are *unconstrained*. In alternate scenarios, complexity is added to the estimation of inputs and Avison-Young parameters for some cargo submarket types (as will be described in Task 5 technical memorandum), but the steps for model calculations are the same for all scenarios.

Submarket Area-Level Constrained Warehouse Space Demand Spatial Allocation Calculations

This stage of calculation allocates the estimated SCAG region-level *unconstrained* demand for warehouse space by cargo submarket type spatially to the 43 submarket areas, while considering constraints of available vacant warehouse space and available developable warehouse space in each submarket area.

In the base year (2014), the SCAG region-level warehouse space is simultaneously allocated to all submarket areas and cargo submarket types, depending on existing warehouse space inventory (as described in Section 3.2 of this document) and base year spatial allocation assumptions (as described in Section 3.2 of this document).

The spatial allocation calculations in the forecast years are similar to Dr. John Husing's "Dirt Theory" approach for spatial disaggregation, as documented in the 2013 SCAG CRGMPIS Task 5 Report, Appendix F, *Distribution of Warehouse Space over Time*. The "Dirt Theory" approach assumes that growth in occupied warehouse space "cascades" from saturated zones to zones that have available land for warehousing. In the context of the SCAG region, this means there will be a gradual shifting of growth in demand to the Inland Empire and to northern Los Angeles County, where vacant land is more plentiful. Dr. Husing identified 25 analysis zones in the SCAG region. His model established zones in "priority order," with zones closer to the ports having the highest priority for receiving projected growth in port-related warehouse demand. Growth in nonport-related demand also was handled zone by zone in priority order. Lowest priority zones were in Imperial County, the Coachella Valley, and Ventura County. The regional forecast of space dictates how much growth has to be allocated to the different zones. Consider the analogy of a supply of water representing the aggregate growth in occupied space. Each zone receives a share of this water up to its capacity; and as capacity runs out in a zone, the remaining water "cascades" into an adjacent zone or near-adjacent zone that still has room. This process continues until all remaining growth is allocated, or until total regional capacity is used up leaving a "deficiency" in supply.

There are some differences in the spatial allocation calculations in this study from the original approach used by John Husing. These include:

- The SCAG region-level occupied warehouse space forecasts were allocated to 43 zones: 33 CoStar submarket areas in Los Angeles, Orange, Ventura, and Imperial Counties; and 10 submarket areas in Riverside and San Bernardino Counties.

- Port and nonport-related cargo submarkets are divided into 13 cargo submarket types, so allocation schemes and "priority orders" are expanded and redefined.
- A minimum vacancy rate for existing warehouse buildings and new developments was reduced from Dr. Husing's assumption of 2.5 percent to 1.0 percent or existing vacancy rate, whichever is lower. The minimum vacancy rate is assumed to represent duration when warehouse building is unavailable for occupation, including renovation activities, and marketing and sale/leasing activities during tenant turnover.
- Vacant warehouse space is based on CoStar Property's® 2014 inventory; and developable warehouse space is based on 2012 SCAG existing land uses data, 2012 SCAG general land use plan data, and the 2014 inventory.

In the forecast years, the SCAG region warehouse space is sequentially allocated to all submarket areas and cargo submarket types, depending on available vacant warehouse space and developable warehouse space (as described in Section 3.2 of this document) and forecast year spatial allocation assumptions (as described in Section 3.2 of this document); and iterated until the last forecast year of 2040. From the year when available vacant and developable space for warehousing are completely filled out, unmet demand by cargo submarket type is estimated for this year onward. The total for allocated warehouse space for all submarket areas is the *constrained* demand for warehouse space.

The order of spatial allocation among cargo submarkets is the same as the increasing order of listing in Table 2.2. This determines the order in which cargo submarkets would use the vacant and developable warehouse space. This order is not intended to represent a priority order for cargo submarkets. At this time, the model does not allow the user to change the order of this allocation.

The steps for spatial allocation remain the same under all scenarios; however, under some of the alternate scenarios (as will be described in the Task 5 report), the available vacant warehouse space and available developable warehouse space change, resulting in change in *constrained* demand for warehouse space.

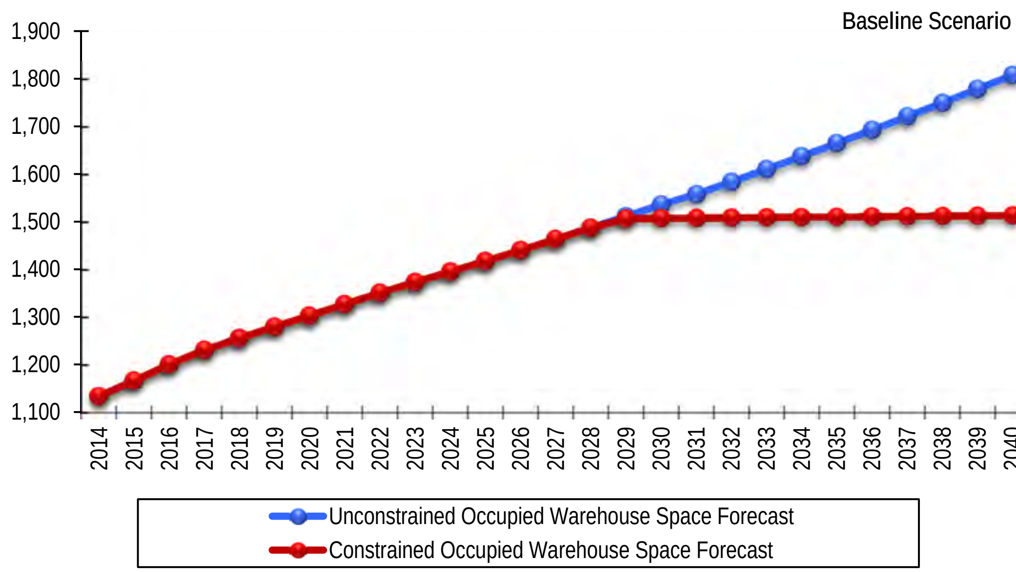
3.4 Model Outputs for Baseline Scenario

2014-2040 Unconstrained and Constrained Region-Level Total Occupied Warehouse Space and Shortfall

Figure 3.11 shows that, under the baseline scenario, the SCAG region would have an *unconstrained* demand for warehouse space of about 1,809 million square feet by 2040, while a *constrained* demand for warehouse space of 1,514 million square feet by 2040. This means a shortfall in capacity of about 295 million square feet by 2040, and it would begin around 2029.

Figure 3.11 Unconstrained versus Constrained Regional-Level Total Occupied Warehouse Space Forecasts by Year in the SCAG Region, 2014-2040

Millions of Square Feet



Source: SCAG Warehouse Space Forecasting Model, Version 1.0, developed in June 2016.

2014 and 2040 Unconstrained and Constrained Regional-Level Warehoused Loads by Cargo Submarket Type

Table 3.14 shows that a majority of warehoused loads in the SCAG region are domestic type, but the growth anticipated in port-related and border-crossing-related warehoused loads is far higher than domestic warehoused loads. Due to shortfall in warehouse space by 2029, the growth in port-related warehoused loads will be curtailed from 106 percent or annualized average growth rate of 2.8 percent, to 90 percent or annualized average growth rate of 2.5 percent, while the growth in domestic warehoused loads will be curtailed from 54 percent or annualized average growth rate of 1.7 percent, to 27 percent or annualized average growth rate of 0.9 percent.

Table 3.14 Regional-Level Warehoused Loads by Cargo Submarket Type, 2014 versus 2040 Unconstrained versus 2040 Constrained

Cargo Market	Cargo Submarket	2014 Warehouse Space (Millions of TEUs)	2040 Unconstrained Warehouse Space (Millions of TEUs)	Percentage Change, 2014-2040	Equivalent CAGR, 2014-2040	2040 Constrained Warehouse Space (Millions of TEUs)	Percentage Change, 2014-2040	Equivalent CAGR, 2014-2040
Port Related		6.6	13.7	106%	2.8%	12.6	90%	2.5%
1	Ports Import Loads to Crossdock Transload Facilities	1.4	3.1	124%	3.2%	2.7	99%	2.7%
2	Ports Import Loads to Small RDCs (<500,000 SF)	0.7	1.4	86%	2.4%	1.3	74%	2.2%
3	Ports Import Loads to Mega RDCs (>=500,000 SF)	1.0	1.9	86%	2.4%	1.8	74%	2.1%
4	Ports Import Loads to Import Warehouses	3.0	6.8	124%	3.2%	6.3	108%	2.9%
5	Ports Export Loads to Export Warehouses	0.5	0.5	14%	0.5%	0.5	7%	0.3%
Border-Crossing Related		0.7	1.5	124%	3.1%	1.5	124%	3.1%
6	Border-Crossing Import Loads to Crossdock Transload Facilities in Imperial County	0.0	0.1	148%	3.6%	0.1	148%	3.6%
7	Border-Crossing Import Loads to Small RDCs (<500,000 SF)	0.0	0.1	115%	3.0%	0.1	115%	3.0%
8	Border-Crossing Import Loads to Mega-RDCs (>=500,000 SF)	0.0	0.1	115%	3.0%	0.1	115%	3.0%
9	Border-Crossing Import Loads to Import Warehouses (Excl. Exports via Ports)	0.3	0.7	128%	3.2%	0.7	128%	3.2%
10	Border-Crossing Export Loads to Export Warehouses (Excl. Imports via Ports)	0.2	0.5	116%	3.0%	0.5	116%	3.0%

Cargo Market	Cargo Submarket	2014 Warehouse Space (Millions of TEUs)	2040 Unconstrained Warehouse Space (Millions of TEUs)	Percentage Change, 2014-2040	Equivalen t CAGR, 2014-2040	2040 Constrained Warehouse Space (Millions of TEUs)	Percentage Change, 2014-2040	Equivalent CAGR, 2014-2040
Domestic		42.7	65.8	54%	1.7%	54.1	27%	0.9%
11	Domestic Loads to Small RDCs (<500,000 SF)	5.9	9.6	62%	1.9%	8.1	38%	1.2%
12	Domestic Loads to Mega RDCs (>= 500,000 SF)	8.1	13.1	62%	1.9%	11.1	36%	1.2%
13	Domestic Loads to GPWs	28.7	43.1	50%	1.6%	34.9	22%	0.8%
Total		50.1	81.1	62%	1.9%	68.2	36%	1.2%

Source: SCAG Warehouse Space Forecasting Model, Version 1.0 developed in June 2016.

CAGR – Calculate Compounded Annual Growth Rate.

2014 and 2040 Unconstrained and Constrained Regional-Level Occupied Warehouse Space by Cargo Submarket Type

Table 3.15 shows that, under the baseline scenario, as there are no efficiency gains in cargo storage, the growth rates in warehouse space are at par with the growth rates in warehoused loads. So, this is the worst case scenario against with alternate scenarios can be compared.

The constraint due to lack of further developable warehouse space in the SCAG region is affecting port-related and domestic loads. This could result in added pressure on warehouse operators for higher cargo turnover rates, and BCOs on faster product sales. It is, therefore, logical to expect greater "pull" logistics than "push" logistics, and the SCAG region may have the ability to absorb some of the unmet demand.

However, there are practical limits in terms of the warehouse operational capacities and year-to-year growth in sales volume of BCOs. In addition, the rental costs for warehouse space in the SCAG region could rise dramatically under a warehouse space shortage situation. Competition from other regions, including Savannah, Charleston, in the U.S. with sufficient land supply and compelling economics, also could serve the unmet demand.

In addition, Figure 3.12 is showing that, under *unconstrained* conditions, share of port-related demand for warehouse space will increase from 11 percent to 16 percent; share of border-crossing-related demand for warehouse space will increase from 1.3 percent to 1.8 percent; and simultaneously, share of domestic demand for warehouse space will fall from 88 percent to 82 percent. Shares of the cargo markets are similar under *constrained* conditions.

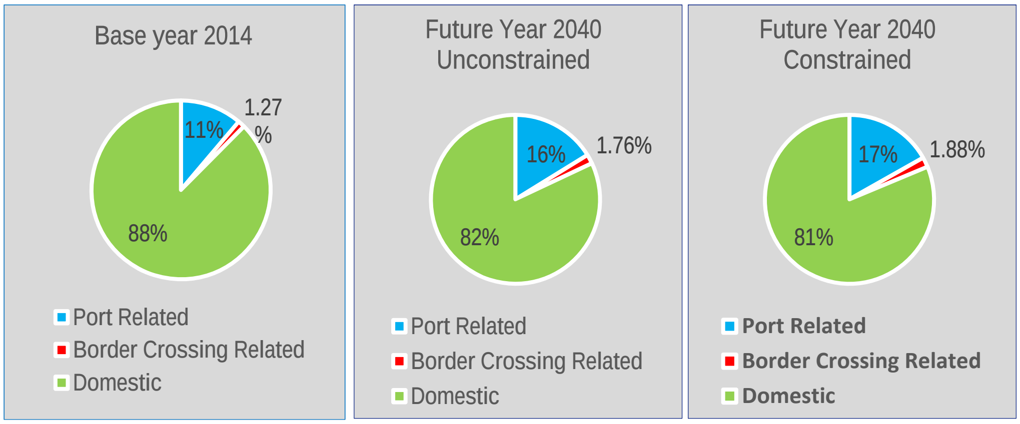
Table 3.15 Regional-Level Occupied Warehouse Space by Cargo Submarket Type, 2014 versus 2040 Unconstrained versus 2040 Constrained

Cargo Market	Cargo Submarket	2014 Warehouse Space (Millions of Square Feet)	2040 Unconstrained Warehouse Space (Millions of Square Feet)	Percentage Change, 2014-2040	Equivalent CAGR, 2014-2040	2040 Constrained Warehouse Space (Millions of Square Feet)	Percentage Change, 2014-2040	Equivalent CAGR, 2014-2040
Port Related		126.6	259.1	105%	2.8%	240.3	90%	2.5%
1	Ports Import Loads to Crossdock Transload Facilities	4.0	9.0	124%	3.2%	8.0	99%	2.7%
2	Ports Import Loads to Small RDCs (<500,000 SF)	16.2	30.1	86%	2.4%	28.2	74%	2.2%
3	Ports Import Loads to Mega RDCs (>=500,000 SF)	11.7	21.7	86%	2.4%	20.3	74%	2.1%
4	Ports Import Loads to Import Warehouses	81.8	183.6	124%	3.2%	170.1	108%	2.9%
5	Ports Export Loads to Export Warehouses	12.8	14.7	14%	0.5%	13.7	7%	0.3%
Border-Crossing Related		14.4	31.8	121%	3.1%	31.8	121%	3.1%
6	Border-Crossing Import Loads to Crossdock Transload Facilities in Imperial County	0.1	0.3	148%	3.6%	0.3	148%	3.6%
7	Border-Crossing Import Loads to Small RDCs (<500,000 SF)	0.8	1.6	115%	3.0%	1.6	115%	3.0%
8	Border-Crossing Import Loads to Mega RDCs (>=500,000 SF)	0.5	1.2	115%	3.0%	1.2	115%	3.0%
9	Border-Crossing Import Loads to Import Warehouses (Excl. Exports via Ports)	6.5	14.7	126%	3.2%	14.7	126%	3.2%
10	Border-Crossing Export Loads to Export Warehouses (Excl. Imports via Ports)	6.5	14.0	116%	3.0%	14.0	116%	3.0%

Cargo Market	Cargo Submarket	2014 Warehouse Space (Millions of Square Feet)	2040 Unconstrained Warehouse Space (Millions of Square Feet)	Percentage Change, 2014-2040	Equivalent CAGR, 2014-2040	2040 Constrained Warehouse Space (Millions of Square Feet)	Percentage Change, 2014-2040	Equivalent CAGR, 2014-2040
Domestic		993.5	1,518.2	53%	1.6%	1,241.9	25%	0.9%
11	Domestic Loads to Small RDCs (<500,000 SF)	129.5	209.7	62%	1.9%	178.1	38%	1.2%
12	Domestic Loads to Mega RDCs (>= 500,000 SF)	93.2	150.9	62%	1.9%	127.1	36%	1.2%
13	Domestic Loads to General Purpose Warehouses	770.8	1,157.7	50%	1.6%	936.7	22%	0.8%
Total		1,134.4	1,809.1	59%	1.8%	1,514.1	33%	1.1%

Source: SCAG Warehouse Space Forecasting Model, Version 1.0 developed in June 2016.

Figure 3.12 Regional-Level Occupied Warehouse Space by Cargo Market Type, 2014 versus 2040 Unconstrained versus 2040 Constrained



Source: SCAG Warehouse Space Forecasting Model, Version 1.0 developed in June 2016.

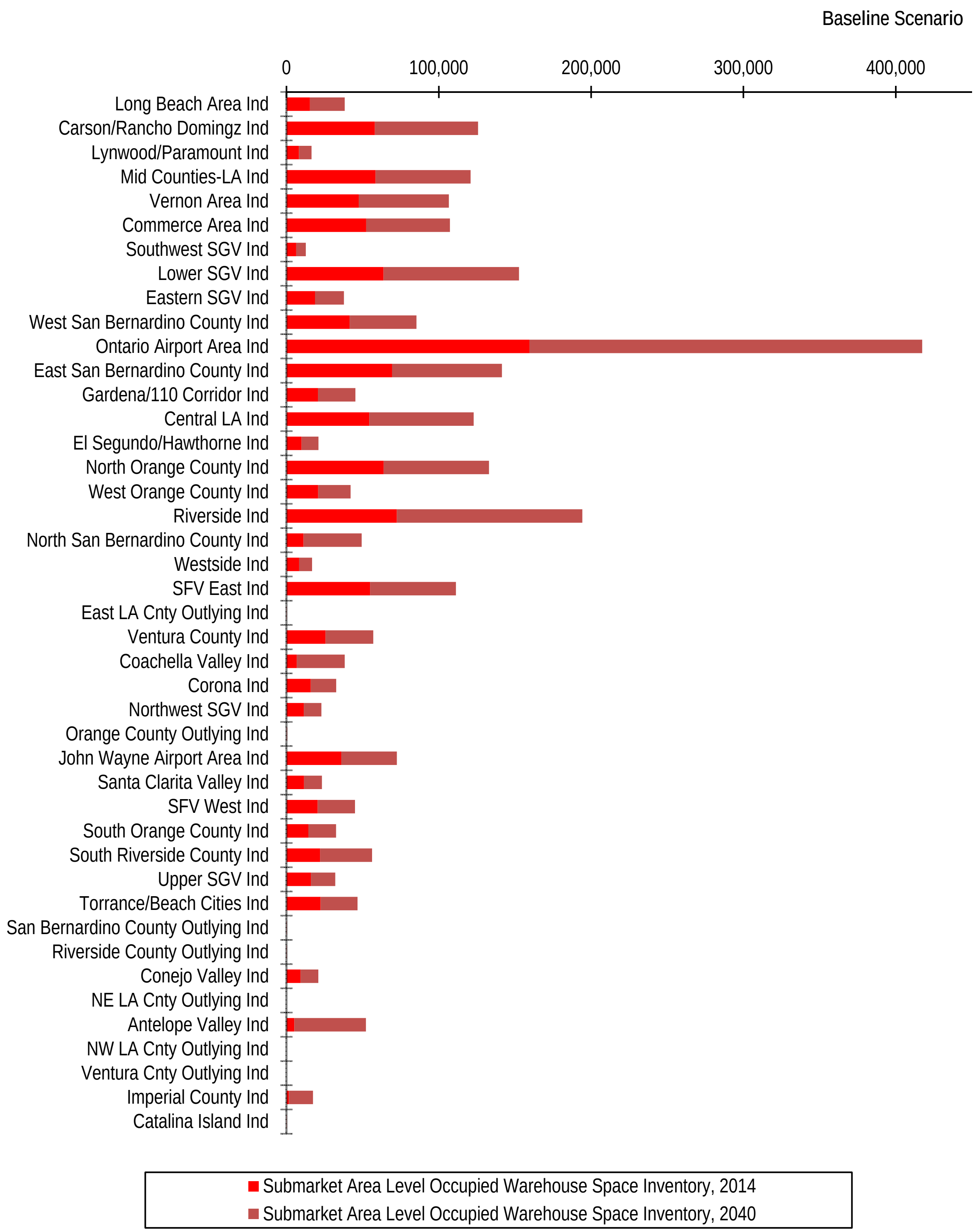
2014 and 2040 Constrained Submarket-Level Occupied Warehouse Space

Based on Figure 3.13 and Table 3.16, by 2040, under *constrained* conditions, the top three submarket areas, in terms of occupied warehouse space share of SCAG region total, would be: 1) Ontario Airport industrial area at 258 million square feet (17.0 percent); 2) Riverside industrial area at 122 million square feet (8.0 percent); and 3) Lower San Gabriel Valley industrial area at 89 million square feet (5.9 percent). East San Bernardino industrial area, North Orange County industrial area, Central Los Angeles industrial area, Carson/Rancho Dominguez industrial area, Mid-Counties Los Angeles industrial area, Vernon industrial area, and San Fernando Valley East are other important submarket areas for future warehousing.

Imperial County is allowed to expand beyond its existing developable space; hence, the warehouse space demand increases from 1.5 million square feet to 15.9 million square feet; mostly in response to growth in border-crossing cargo.

Figure 3.13 Submarket Area-Level Occupied Warehouse Space, 2014 versus 2040 Constrained

Thousands of Square Feet



Source: SCAG Warehouse Space Forecasting Model, Version 1.0 developed in June 2016.

Table 3.16 Regional-Level Occupied Warehouse Space by Cargo Submarket Type, 2014 versus 2040 Unconstrained versus 2040 Constrained

Submarket Area	2014 Warehouse Space (Thousands of Square Feet)	2040 Unconditional Warehouse Space (Thousands of Square Feet)	Percentage Change, 2014-2040	Equivalent CAGR, 2014-2040
Long Beach Area Ind	15,431	22,845	48%	1.5%
Carson/Rancho Domingz Ind	58,063	67,715	17%	0.6%
Lynwood/Paramount Ind	8,213	8,228	0%	0.0%
Mid Counties-LA Ind	58,491	62,376	7%	0.2%
Vernon Area Ind	47,418	59,179	25%	0.9%
Commerce Area Ind	52,349	54,952	5%	0.2%
Southwest SGV Ind	6,339	6,341	0%	0.0%
Lower SGV Ind	63,737	88,921	40%	1.3%
Eastern SGV Ind	18,764	18,919	1%	0.0%
West San Bernardino County Ind	41,460	43,857	6%	0.2%
Ontario Airport Area Ind	159,545	257,776	62%	1.9%
East San Bernardino County Ind	69,335	72,127	4%	0.2%
Gardena/110 Corridor Ind	20,659	24,580	19%	0.7%
Central LA Ind	54,367	68,519	26%	0.9%
El Segundo/Hawthorne Ind	9,895	11,067	12%	0.4%
North Orange County Ind	63,803	69,181	8%	0.3%
West Orange County Ind	20,847	21,250	2%	0.1%
Riverside Ind	72,430	121,786	68%	2.0%
North San Bernardino County Ind	11,208	38,143	240%	4.8%
Westside Ind	8,335	8,461	2%	0.1%
SFV East Ind	54,897	56,310	3%	0.1%
East LA Cnty Outlying Ind	17	22	31%	1.1%
Ventura County Ind	25,676	31,285	22%	0.8%
Coachella Valley Ind	6,742	31,512	367%	6.1%
Corona Ind	15,899	16,732	5%	0.2%
Northwest SGV Ind	11,367	11,523	1%	0.1%
Orange County Outlying Ind	240	240	0%	0.0%

Submarket Area	2014 Warehouse Space (Thousands of Square Feet)	2040 Unconditional Warehouse Space (Thousands of Square Feet)	Percentage Change, 2014-2040	Equivalent CAGR, 2014-2040
John Wayne Airport Area Ind	35,994	36,518	1%	0.1%
Santa Clarita Valley Ind	11,537	11,721	2%	0.1%
SFV West Ind	20,516	24,480	19%	0.7%
South Orange County Ind	14,323	18,266	27%	0.9%
South Riverside County Ind	22,015	34,129	55%	1.7%
Upper SGV Ind	15,988	16,078	1%	0.0%
Torrance/Beach Cities Ind	22,402	24,225	8%	0.3%
San Bernardino County Outlying Ind	106	115	9%	0.3%
Riverside County Outlying Ind	112	112	0%	0.0%
Conejo Valley Ind	9,209	11,737	27%	0.9%
NE LA Cnty Outlying Ind	0	0	0%	0.0%
Antelope Valley Ind	5,166	46,970	809%	8.9%
NW LA Cnty Outlying Ind	0	0	0%	0.0%
Ventura Cnty Outlying Ind	0	0	0%	0.0%
Imperial County Ind	1,540	15,889	899%	9.3%
Catalina Island Ind	2	2	0%	0.0%
Total	1,134,435	1,514,091	33%	1.1%

Source: SCAG Warehouse Space Forecasting Model, Version 1.0 developed in June 2016.

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