Rail Transportation of Aggregate Material

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Sand, gravel and crushed stone, known as construction aggregates, are the main ingredient in materials to maintaining and building new infrastructure. Construction aggregate has a low cost per ton, but because mass quantities are typically required, if a local source is not available then the cost of transportation quickly exceed the value of the material. The North Bay Area has an estimated 50-year demand of 521 Million Tons (MT) and a current permitted supply of 110 MT. This North Bay Area region has a supply to demand ratio of 21% and is estimated to last 11-20 years (from 2012). This demand study does not include the extreme increase in demand that Senate Bill 1 (SB-1) will require. A culmination of increased aggregate demand from SB-1, continued construction growth in the Bay Area, increased trucking cost, and environmental resistance to new quarry permits might significantly accelerate the aggregate shortage in the North Bay Area. As a possible solution to these circumstances, a feasibility study has been performed on bringing aggregate in by rail from a region with a surplus of permitted aggregate to meet the local demand.

Key Words: Construction Aggregate, Senate Bill 1, Quarry, North Bay Area, Rail

Introduction

This study is to provide a real-time analysis of what the cost variance is between using rail to transport a discounted outside source of aggregate in a region with a surplus, compared to the cost of a local source in the North Bay Area. Prior to this study it was known that the local source is cheaper than using rail to transport an outside source. The true purpose of this study is not for the current market but to provide a price point so in the future, as the cost of aggregate rises, one can start to evaluate the use of rail as a solution to a local shortage of aggregate.

Construction aggregates are typically in a large surplus in almost every state in the United States. California State Geologist estimate that the state has 78 billion tons of aggregate that has not been mined. Only 5% of the 78 billion tons is permitted to be mined. While the cost of high quality aggregates has continued to raise dramatically in coastal cities such as San Francisco, Los Angeles and San Diego, because of local material resources being depleted, all three cities have suppliers in contract with the Polaris Mine in British Columbia to supply aggregate by ship for the next 20 years. This 20-year contract proves the industry has already decided that outsourcing aggregates are more economical for these cities.

Aggregate has a low unit value and high bulk weight. This means that the cost per ton of aggregate is low, but because it is a material that requires mass quantities, the aggregate must come from a local source or the expense to transport the material will quickly exceed the value of the material itself. While local sources are reaching the end of their supply it is important to understand the relationship that transportation will play in the cost of outsourcing aggregates. The North San Francisco Bay Areas is arguably the top environmentally conscious regions in the United States if not the world. While a large number of residents in Marin and Sonoma County claim to be environmentalist or environmental conscious, this mindset of the people directly and strongly influences the local agencies that regulate and permit new quarry's. In the last 10 years there have been less than 5 very small (quarry's that produce less than .5 million tons per year) new quarries that have been permitted to mine aggregates. There

have not been any new permits given for large quarry's (quarry's produce 1.5 million tons or more per year) in Marin or Sonoma in the last 20 years. Thus, for the sake of this study it is reasonable to make the assumption that it is very unlikely that any new large quarries will be permitted in the near future.

Literature Reviews

Aggregate Sustainability in California – California Geological Survey Department of Conservation

The Department of Conservation for the state of California preformed an extensive study in 2012 of the aggregate sustainability in California. Map Sheet 52 is included in the Appendix B and is the most straightforward way to quickly understand the aggregate supply and demand that is projected over the next 50 years. The data that went into this map sheet has been collected for that last 30 years and is the premire resource that material suppliers use to evaluate the aggregate market on a state level. It is estimated that the North Bay Area will demand 521 million tons (MT) for construction aggregate for the next 50 years (from 2012). According to the State the North Bay Area is only permitted to supply 110 MT for the next 50 years. The Department of Conservation estimates that this local supply of aggregate will be completely depleted in the next 11 – 20 years (from 2012). This is a 21% supply to demand ratio.

The Stockton / Lodi region is one of the closest areas, approximately 120 miles away, that has a larger supply than demand over the next 50 years. This region has a 50-year supply of 436 MT and a 50 Year demand of 232 MT. This is a 188% supply to demand ratio that is project to last 31 to 40 years. It is also reasonable to assume that new permits for quarries are more likely to be given in the rural area of Stockton than the North Bay Area. While looking at the map it is clear that there is also a surplus of material in the West Sacramento area, but the Sacramento region itself is at one of the largest deficits in the state. Sacramento is projected to have less than 10 years of permitted resources left and has a supply to demand ratio of 7% for the next 50 years. For my study I assumed that the west Sacramento- Fairfield region would be primarily used to supply Sacramento because Sacramento County will reach a deficit sooner and its relative proximity. In total the state has a 50-year demand of 12,047 MT and a permitted supply of 4,067 MT, which totals a 34% supply to demand ratio.

State of California DOT Memorandum

The Department of Transportation released this memorandum primarily in response to the projected demand increases that will result from Senate Bill 1. This memo encourages material suppliers, contractors, and state agencies to start brainstorming ways to avoid a shortage of aggregate. Long truck hauls are considered at 50 miles and because of environmental impacts and cost the State wishes to reduce all aggregate hauls to less than 50 miles. The memo also addresses that in addition to SB 1, the California High Speed Rail, which has a construction timeline from 2015 – 2029, will increase aggregate demand. Construction aggregate use is approximately 34% residential, 17% commercial and a remaining 43% for public infrastructure. The memo states that the cost of shipping aggregates in some cases out weigh the cost of the material if it is trucked more than 20 miles.

Methodology

The objectives of this feasibility study are as follows:

- Summarize the market supply of aggregate in the North Bay Area for the next 50 years
- Summarize the market demand of aggregate in the North Bay Area for the next 50 years
- Select a quarry to outsource from and a supply yard with rail access
- Develop a logistics map

- Spectate possible implications that would accelerate demand
- Preform a cost analysis of when rail is more economical feasible than trucking
- Estimate the cost building a spur line and setting up a storage yard for aggregate
- Estimate the cost to bring aggregate into the North Bay Area by rail
- Compare and evaluate the results of rail transportation

Logistics Summary

Appendix A is a Google Earth file that was created for strategic planning. In A2 is the all the rail lines in California. A1 is the supply quarry, Newman Minerals in Ione Ca. This quarry was chosen because it already has accesses to load rock by rail, elevating the need to find a quarry that has the possibility to install a new spur line. Based off the State Geologist this quarry and general area has a large surplus of permitted aggregate compared to its local demand. A1 also includes the proposed location the material would be shipped and stored. The pin called Redwood Landfill is the proposed storage site and is located in Novato Ca. This site was located because the land is owned by a local waste management company that has a history to long term leases with local construction firms. The Northwestern Rail line also runs through their property. This would be a site likely to be permitted because there is a very small active quarry they lease to local construction firm. It is already considered a brownfield site and it would be unlikely that there would be environmental resistance to place a small spur line and use the already active quarry as a storage site for railed in aggregate. This is also a strategic location because of large on and off ramps in both the North and South direction that give freeway access, as well as surrounding interstate connections. The storage site is approximately 30 miles north of San Francisco and is directly off of Highway 101. As mentioned in the State of California DOT Memorandum and in figure 2 trucking is efficent to haul aggregate up to 50 Miles. This allows trucking to competitively move this material in San Francisco, Marin, Sonoma, Healdsburg, Contra Costa, Solano and Napa counties. A 50-mile radius is shown on A3. A4 is a map of local material suppliers. This includes any type of material supplier from raw aggregate to asphalt and concrete.

Trucking verse Rail

While using rail is not competitive with trucking now, it will become more and more competitive the further the distance traveled, and the more quantity being transported. *Figure 1* has two parts; Analysis for 120-mile roundtrip, and analysis for 240-mile roundtrip. The first analysis is to show that at 60 miles in one direction the cost per ton is equal to the cost per ton to buy the aggregate (local supply virgin aggregate $15-$17). This means that 1 truck is only able to make 2.4 trips in an 8-hour shift delivering on 60 tons per day. This is a very inefficient way of moving aggregate. There is no data to compare the cost of using rail at this distance, but it is to show that trucking starts to become inefficient at half the distance from the Ione Minerals quarry. The Ione quarry is 120 miles away making 240-mile roundtrip, allowing for 1.33 trips per day and only suppling 33 tons per day. The cost per ton significantly increases costing $28.80 per ton. The cost per ton to use rail from Ione to Novato is only $15.85. This is a $13 variance in just transportation of aggregate per ton and does not include the reduced cost of aggregate in Ione compared to Sonoma county.

Trucking analysis for 120 Mile Roundtrip		
Load and Unload Hr.		0.67
120 Mile Roundtrip Travel Time Hrs.		2.67
Total Hours 1 Roundtrip		3.33
Total Trips in 8 Hrs.		2.40
Tons Per Trip		25
Total TNs Per Day		60
$120 Hour Rate- Cost for 8 Hr. Shift	$	960
Cost per TN 1 Truck per Day	$	16

Trucking analysis for 240 Mile Roundtrip		
Load and Unload Hr.		0.67
240 Mile Roundtrip Travel Time Hrs.		5.33
Total Hours 1 Roundtrip		6.00
Total Trips in 8 Hrs.		1.33
Tons Per Trip		25
Total TNs Per Day		33
$120 Hour Rate- Cost for 8 Hr. Shift	$	960
Cost per TN 1 Truck per Day	$	28.80

Figure 1: Trucking Analysis

It is also important to consider the future of the trucking industry in California. The California Air Resource Board (CARB) has been increasing Tier compliance regulations significantly and plans to continue to increase regulations. Increasing the Tier compliance will force California truckers to buy new trucks ultimately driving up the cost to move material and making rail more competitive. Another concern that the trucking industry in California faces is the possibility of certified payroll. Currently trucking agencies do not have to show the state a certified payroll and there is no pre-vailing wage that is required for CA. state truckers. If a pre-vailing wage is set and certified payroll is enforced on the trucking industry it will dramatically increase the cost. The possibility in the next 10 years of CARB increasing tier compliance as well as California law makers enforcing certified payroll should be strongly considered when evaluating the future of rail verse trucking. Figure 2 shows the import quantity of 1 million tons per year. According to the state geologist and their estimated 50-year demand, the yearly demand is an estimated 2.2 million tons. Thus, 1 million tons with an empty local supply is a fair estimate of what would possibly be used. *Figure 2* also shows the number of cars trips needed to meet 1 million tons per year. There are also several environmental advantages that rail presents over trucking that are clearly explained in detail in an another paper that is included in the appendix.

Material Production			
Supply			
Yearly Demand TN	1,000,000	**Trips Per Year**	**100**
Rail Hoppers Cars	100		
Tons Per Car	100		
Tons Per Trip	10,000		

Figure 2: Material Production

Increased Demand and Senate Bill 1

Senate Bill 1 (SB 1) passed in April of 2017 and allocates $54 billion over the next 10 years to be spent on public infrastructure. Public infrastructure such as roads, bridges, dams and highways use the more aggregate per cost of construction than any other type of work. SB 1 raises over $5 billion a year, which is historically significant because that is a 45% increase over the current state funding. This study was based in the most recent supply and

demand data from the State of California which was conducted in 2012. Thus, the demand estimates did not account for this dramatic increase that SB 1 will carry.

Operating Expenses

With help from Northwestern Pacific Railroad the following estimates were made to evaluate the cost of renting or buying rail equipment. The cost to rent 100 open-top hopper rock cars and a locomotive is shown in *figure 3*. Below that is the cost to buy the same 100 cars and locomotive. Below that is a rent to buy break even analysis. To complete 100 trips per year the train would have to do roughly 8.3 trips per month. With this high use frequency, it would take roughly 2 months of renting to break even with purchasing the rock cars and locomotive. Below that the cost for just transportation of rail per ton is calculated to be $15.85.

Cost to Operate					
Description: Rent 100 cars & Locomotive 1 Roundtrip- Assume Rent 1 Month Min.					
Expense		Cost	Quantity		Total Cost
Rail Freight Cost	$	1,200	100	$	120,000
Open Top Hopper Cars Rent / Month	$	400	100	$	40,000
Locomotive Rent	$	150	10	$	1,500
Fuel Cost / Mi	$	300	120	$	36,000
			Contingency 10%	$	19,750
			Total	$	217,250

Cost to Operate					
Description: Own 100 cars & Locomotive 1 Roundtrip					
Expense		Cost	Quantity		Total Cost
One Time Expenses					
Open Top Hopper Cars Purchase	$	17,500	100	$	1,750,000
Locomotive Purchase	$	175,000	1	$	175,000
			Contingency 5%	$	96,250
			Total	$	2,021,250

Rent or Buy Break Even		
Trips Per Month Evenly Spaced Through Year		8.3
Fixed Rental Cost Per Month	$	41,500
Variable Cost for 8.3 Trips per Month	$	1,300,000.00
Total Cost for 8.3 Trips in one month Renting	$	1,341,500
Months to Break Even		1.51

Figure 3: Cost to Operate

Figure 4, Scenario One, is a summary of what cost to use rail to bring outside aggregate is compared to the current local market cost. It was clearly understood before conducting this study that using rail at this time is not efficient and the calculation below clearly shows that with an $8.85 variance.

Scenario 1 1MM Tons / Year Own Equipment - 100 Trips		
Trips Per Year		100
ONLY Rail Cost per TN*	$	15.85
Cost 1 MT Just Rail	$	15,852,125
Cost Per TN to buy from Ione	$	10.00
Cost to Buy 1 MT		10,000,000
Cost to Supply 1MM TN Per by Rai		25,852,125
Cost Per Ton By Rail From Ione		25.85
Local Sonoma Agg. Price / Ton		17.00
Current Difference		(8.85)

Percent Increase Needed to Break Even 1MM Tons / Year Own Equipment - 100 Trips	
Percent Needed To Break Even wit	52%
51% Increase of Local $17	25.67

Figure 4: Scenario One

Conclusion

While it is clear that rail is not efficient in the current market place, this study provides significant evidence that it may be a viable solution to a possible upcoming shortage of construction aggregate. There were several assumptions made for this study to become feasible. The first assumption that had to be made or this study warrants no purpose is that local and state agencies will not give a significant number of new permits to mine aggregate in the North Bay Area that will change the supply to demand ratio. Understanding that the majority of the existing permits were given over 20 years ago and the urbanization and environment preservation of the Bay Area has dramatically increased provides a solid basis that the current 50-year supply to demand ratio of 21% is so low any new permits will have minimal effect on this ratio. This assumption was made with a high degree of certainty and thus was the conditioning reason to move forward with the study. Several factors that were mentioned such as, certified payroll and prevailing wage for trucking, increased demand and Senate Bill 1, are very legitimate conditions that were not included in my calculations but could dramatically make this study for the use of rail more feasible. There was no speculation made to how the price of aggregate will change to the reducing supply, but it is fair to assume that it will directly correlate to the local supply and the cost of trucking. My study concludes that in the current market the price of aggregate in the North Bay Area increases 52% then using rail to haul aggregate from Ione would be efficient. When considering the State Department of Conservation estimates that in 11-20 years (from 2012) the local supply could be entirely exhausted it is not extreme to consider an increase in price as high as 52%. As local supply diminishes the determining factor of aggregate will be primarily based off of transportation because aggregate has a low unit value and high bulk weight.

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