Arizona aggregates; 1950 to 2014 and beyond

by William H. Langer and Steve Trussell

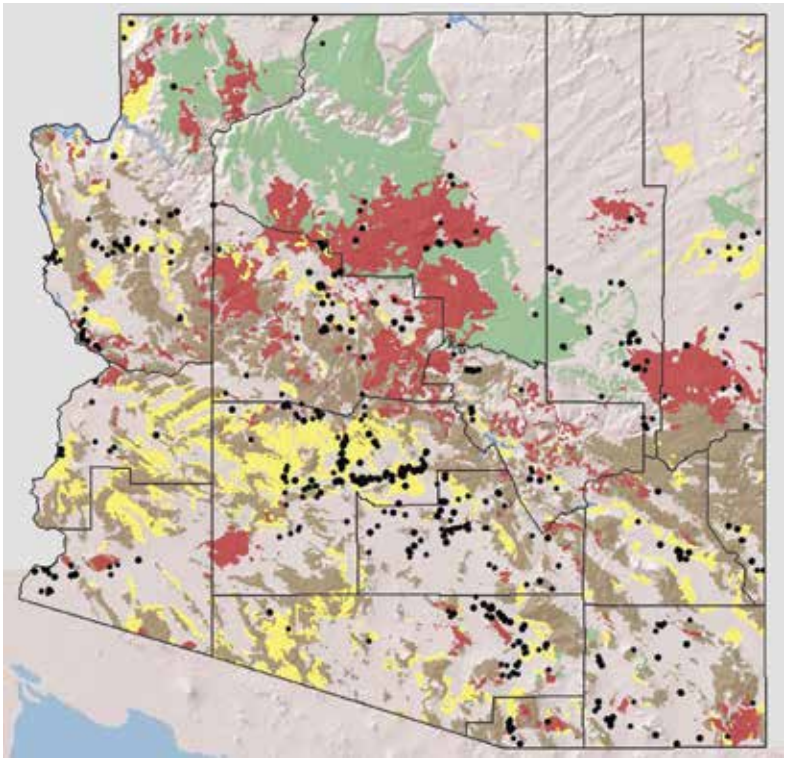
Arizona aggregate (sand, gravel and crushed stone) producers enjoyed more than a half a century of nearly constant growth in demand for aggregates. Approximately 80 percent of the aggregate produced in Arizona is sand and gravel, and 20 percent is crushed stone (U.S. Geological Survey, 2015). Figure 1 shows the generalized distribution of potential sources of sand and gravel (yellow) and potential sources of crushed stone (other colors described below). Black dots show locations of aggregate operations.

Sand and gravel commonly is produced from modern river channels and terraces although some alluvial fans and high-level paleo-river terraces also serve as aggregate resources. The gravel clasts are a mix of rock types that reflect the types of rock in the source area of the rivers. Generally processed river gravels meet stringent specifications for high-end uses.

Crushed stone, which makes up about 20 percent of production, primarily comes from a variety of metamorphic rocks and light-colored intrusive igneous rocks such as granite (brown areas), dark colored extrusive igneous rocks such as basalt and scoria (rust colored areas), and carbonate rocks such as limestone or dolostone (green areas). Carbonate rocks are also used in the manufacture of cement and lime.

Figure 1

Map showing potential sources of sand and gravel and crushed stone, and locations of aggregate producers in Arizona.



Construction and aggregate production in Arizona

Because aggregate producers have limited facilities for storing product, stockpile changes are insignificant compared to production. Therefore, demand or consumption of aggregate in Arizona is considered to be equal to production. Production figures used in this paper reflect shipments, sales or marketable production, including aggregate used by producers to make readymix concrete and asphalt. Production figures were reported by the U.S. Bureau of Mines from 1950 until 1995 and by the U.S. Geological Survey (USGS) since then. Production figures are reported voluntarily, and major operators are the primary source for these figures. Because many smaller operators do not report their production, the figures are conservative values that provide an approximation of aggregates production activity.

The construction industry is the primary consumer of aggregates that are used to build roads, rail lines, bridges, office buildings, hospitals, schools, airports, factories, homes and so forth. Many of those uses of aggregate come about to support the growth in population. But as has been observed during the past decade, construction, and consequently aggregate production and demand, fluctuate with the state of the economy.

Figure 2 shows the relationships among aggregate production (blue line), population (green line), and recessions (gray vertical bars), and shows trend lines (red lines) for production in tons per capita (per person) for two periods; 9.96 t (11 st) per capita during 1950-2000, and 14.34 t (15.8 st) per capita during 2000-2007.

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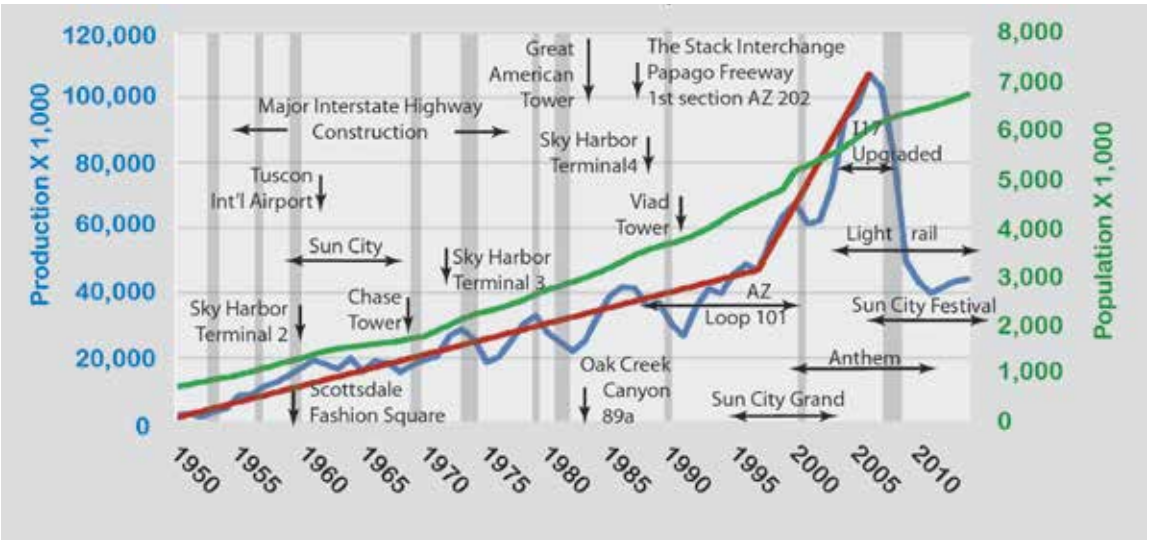
Figure 2

Graph showing aggregate production, population, recessions and some major construction projects in Arizona for the years 1950 - 2014.



United States into World War II brought the construction of a large number of military facilities in Arizona. Those military facilities brought a major influx of new residents to the state, many of whom chose to remain in Arizona. The advent of air conditioning in the early 1950s further supported the population growth in Arizona. During 1950, the state's population was about 750,000.

That population growth stimulated non-government construction, both residential (ie. Sun City) and commercial (ie. Scottsdale Fashion Square and Chase Tower). In addition, the Federal Aid Highway Act of 1953 and Highway Revenue Act of 1956 provided funding for accelerated highway construction. Much of the Interstate Highway System in Arizona was built from 1953 to 1975. By 1970, the state's population had more than doubled to 1.8 million.

By 1990, Arizona's population had reached 3.7 million, once again doubling in two decades. During the latter part of the 20th century, state-funded highway projects (ie. AZ Loop 101 and 202), new residential communities (ie. Sun City Grand), and continued development of large office buildings (ie. Viad Tower) continued to push the demand for aggregates.

From 1950 to 2000, aggregate production in Arizona averaged nearly 10 t (11 st) per capita. Production dipped following a number of recessions but recovered within five years of the start of the recessions. Examples include the 1973-1975 recession marked by the 1973 oil crisis and the 1973-1974 stock market crash (35 percent decrease in production); the early 1980s recession caused by the 1979 energy crisis and Iranian Revolution (33 percent decrease); and the early 1990s recession prompted by the Federal Reserve raising interest rates and the 1990 oil price shock (27 percent decrease).

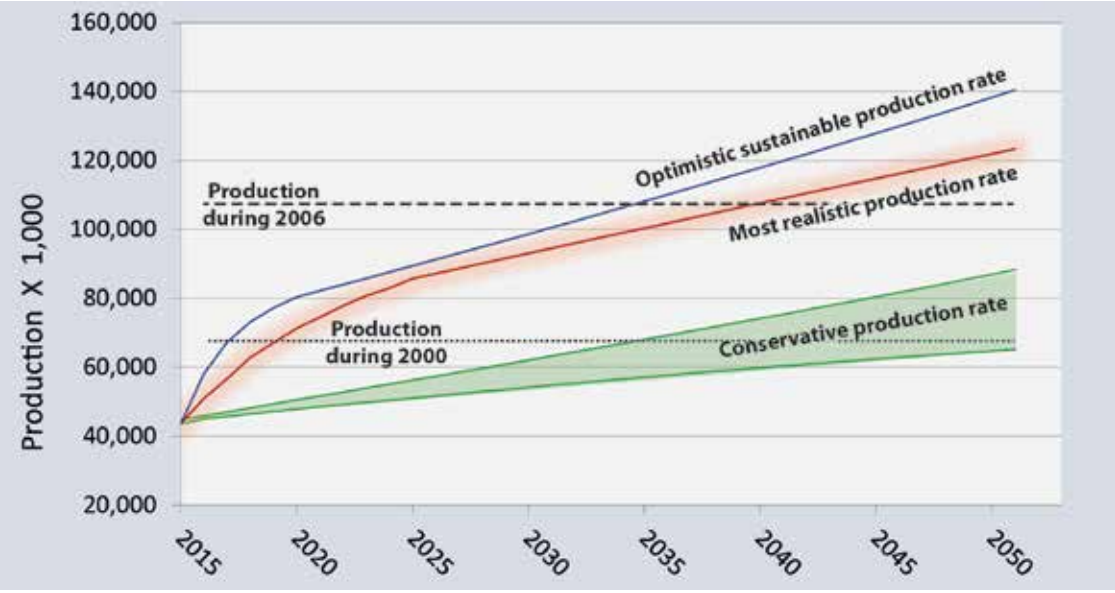
At the start of the 21st century, Arizona's population was 5.2 million. The first seven years of the 21st century was a period of record high aggregate demand in Arizona. Demand for aggregates from 2000 to 2007 was nearly constant, at an average of 14.34 t (15.8 st) per capita except for a slight dip in production following the early 2000s recession caused by the dot com bubble collapse (Fig. 2).

A major player in the demand for aggregate was the boom in residential construction (ie. Anthem). During 2000, 59,765 housing unit building permits were issued. That was a rate of one unit for every 3.35 new residents. During 2005, the number of housing unit permits issued soared to 89,577, a rate of one unit for every 2.09 new residents. Demand was so great that there were cement shortages in the Phoenix area, and cement and readymix deliveries were based on allocations. Construction could not keep up with demand and, in some planned communities, houses were sold through lotteries.

History shows that the inflated housing market supported by subprime mortgages was not sustainable. The all-time high period of aggregate production that supported the housing boom came to a dramatic end during the Great Recession (2007-2009). Between 2008 and 2011, aggregate production fell 63 percent, reaching a low of 39.86 Mt (43.9 million st) in 2009, a rate not experienced since 1992.

Figure 3

Graph showing four aggregate production forecasts and historical rates of production for the years 2000 and 2006.



Arizona aggregate production has not fully recovered. A few major construction projects were undertaken including the upgrading of Interstate 17. During 2014, five years following the end of the Great Recession, aggregate production in Arizona was 44.1 Mt (48.6 million st), only 41 percent of the record high production of 107.3 Mt (118 million st). Demand for aggregate since 2011 has been less than 7 t (7.7 st) per capita and has not been that low since the start of the Interstate Highway System in 1953.

Economic impact of aggregate production

Table 1 shows a comparison of the economic impact of the rock product firms in Arizona for the year 2006, just prior to the Great Recession, with the year 2014. The economics of the Arizona aggregate industry and closely associated industries (ready-mix concrete and asphalt suppliers, manufacturers of precast concrete products such as pipes, and producers of cement, gypsum and lime) are far-reaching. During 2005, taken together these rock product firms employed 11,211 Arizona workers with a direct output of $2.7 billion. Contrast that with 2014 when these rock product firms employed 6,272 Arizona workers with a direct output of $1.7 billion.

These dollars cycled back into the economy. Rock products firms pay their workers and purchase materials and services from Arizona suppliers, who in turn purchase from their own suppliers and make payments to their employees. Taxes paid by firms and workers provide revenues for government spending. Adding these indirect impacts, the Arizona rock product industries created a total economic impact of $5.1 billion and 240,000 jobs in 2005, and $3 billion and 125,330 total Arizona jobs in 2014 (WP Carey School of Business, 2005, 2014).

Arizona aggregate production forecast model

Based upon historical data, there appears to be a high degree of correlation between population and aggregate production. Population projections were correlated with historical production figures on a yearly basis to forecast aggregate production in Arizona for the years 2015-2050.

The Arizona Department of Administration (2012) has prepared three population projections for 2012-2050, low, baseline and

Table 1

Economic impact of Arizona rock product firms in 2005 and 2014.

	2005	2014
Direct impact		
Workers employed	11,211	6,272
Direct output	$2.7 billion	$1.7 billion
Total impact		
Workers supported	240,000	125,330
Total output	$5.1 billion	$3 billion

Agua Fria River west of Phoenix, AZ.

high. Those values, which are variables that increase over time, are the first input to the production forecast model.

Future aggregate production estimates are based on two production rates, the current rate and a sustainable rate. Aggregate has been produced at a rate of about 6.71 t (7.4 st) per capita since the end of the Great Recession. That is considered to be the low production rate. The aggregate production rate of 10.67 t (11.7 st) per capita during the last half of the 20th century is assumed to be sustainable, and is considered to be the baseline production rate. It is noted that the years 1950-1954 have been excluded from this future production analysis because those were years of uncharacteristically low per capita production prior to the construction of the Interstate Highway System.

Four aggregate production forecast models were prepared for the years 2015-2050 (Fig. 3). The starting point for each model is the 2014 production level of 44.1 Mt (48.6 million st).

Two models, shown by the green lines (Fig. 3) are based on production continuing at the current rate of 6.71 t (7.4 st) per capita. The lower green line forecasts aggregate production in Arizona for the low population scenario; the upper green line for the high population scenario. The zone between the two green lines is considered to be the most conservative long-term rate of production.

The highlighted red line (Fig. 3) forecasts aggregate production at the sustainable baseline rate of 10.67 t (11.7 st) per capita for the baseline population scenario. Production is ramped up from the current rate of 6.71 t (7.4 st) per capita to 10.67 t (11.7 st) per capita over a 10-year period. The red line is considered to forecast the most realistic long-term forecast of aggregate production.

The blue line (Fig. 3) forecasts aggregate production at the sustainable baseline rate of 10.67 t (11.7 st) per capita for the high population scenario. Production is ramped up over a five-year period. The blue line is considered to forecast the most optimistic sustainable rate of production.

The dotted line and dashed line (Fig. 3) show the level of aggregate production in Arizona (67.43 Mt or 74.3 million st) during 2000 and the highest recorded level of aggregate production (107.3 Mt or 118 million st) during 2006, respectively. If aggregate production in Arizona follows the baseline forecast (red line), production will reach the level of production during 2000 by 2019 and will fully recover to the 2006 level by 2039. If production follows the high level forecast, it will reach the 2000 level by 2017 and will fully recover to the 2006 level by 2034.

Under the most conservative scenario of this modeling technique, production is not predicted to fully recover to the highest historic level of production by 2050.

Summary

Aggregate production in Arizona averaged about 10 t (11 st) per capita during the last half of the 20th century. During the first decade of the 21st century, production grew rapidly until the Great Recession in 2006. Production then fell to a rate last seen in 1994. Four different models forecast future aggregate production rates, with the baseline model showing production returning to the highest historic level achieved during the year 2006 by 2039. ■

References

Arizona Department of Administration, 2012, Arizona state and county population projections, 2012-2050: https://population.az.gov/population-projections, accessed October 1, 2015.

WP Carey School of Business, 2005, Economic Update & Outlook, Arizona Rock Products Convention: Arizona State University, Phoenix, Arizona, 56 p. slide presentation.

WP Carey School of Business, 2014, Economic Impact of the Arizona Rock Products Industry: Arizona State University, Phoenix, Arizona, 25 p.