LEVELTON
Engineering Solutions

APPENDIX F

PORTLAND CEMENT CONSUMPTION IN BRITISH COLUMBIA
OREGON STUDY ON RECYCLING

SHIPMENTS OF PORTLAND CEMENT IN BRITISH COLUMBIA
1985 TO 1994
WITH ESTIMATES TO 1999

YEAR	SHIPMENTS (TONNES)
1985	632,100
1986	642,400
1987	705,000
1988	792,000
1989	1,036,000
1990	1,096,000
1991	1,050,000
1992	1,138,000
1993	1,160,000
1994	1,213,000
1995*	1,182,000
1996*	1,198,000
1997*	1,270,000
1998*	1,335,000
1999*	1,315,000

* Indicates estimated value

Excerpt from: **"An Economic Analysis of Construction Aggregate Markets and the Results of a Long-Term Forecasting Model for Oregon".**

Is Recycling Going to Reduce the Need for Mining?

Recycling is reducing Oregon's need for virgin aggregate. We estimate that 3.8% of Oregon's aggregate in 1993 came from recycled materials. Our forecast shows this more than doubling to 8.6% by 2050.

The impact of recycling is large. In our forecast, recycling reduces virgin aggregate consumption by 188.9 million tons for the years 2001 to 2050. With the average commercial mine producing 83,159 tons annually[17], recycling eliminates the need for 45 operating mines each year. Over the fifty-year forecast, recycling cuts back the need for over six square miles of landfills.[18]

There are limitations to recycling. Technical issues related to processing and use are major hurdles. Recycling is also largely unresponsive to prices. For instance, people do not tear up old pavement for recycling because the price of aggregate goes up.

Low volume is another constraint. Normally, recycling is economic only if large quantities are in one location and processed at once. Because most sources are small, there tends to be more recycling in cities. They have larger and more concentrated waste streams.

High stockpiling costs hinder recycling. It costs money to collect, truck, and process recycled materials. These expenses cannot be recovered until the materials are sold. Sales, however, depend on new construction projects. Often, there are long time lags before sales. As a consequence, recycled materials can remain stockpiled for extensive periods. The investment needed to finance these inventories is a burden especially in rural areas.

The most important limitation is the difference in gross volumes. Oregonians simply use far more aggregate than they can possibly recover from waste streams. Currently, daily aggregate use in Oregon is 96 pounds per person. That is well above the amount of solid wastes generated.

Roads are the largest source of recycled aggregate in Oregon. We estimate that repair and maintenance work on paved roads generate 633,000 tons of recoverable wastes each year.[19]

While recycling has limitations, it is a growing activity. New, innovative ways are being introduced each year for collecting, processing, and using wastes. Recycled materials are finding more acceptance as alternatives to virgin aggregate by the construction industry. Growth is also being fueled by rises in landfill disposal costs, virgin aggregate prices, and trucking rates. Recycled materials will never dominate the market, however. Ultimately, we believe the use of recycled materials will level off at about 10% of total aggregate consumption. The percentage will be higher in cities but lower in rural areas.

What Materials Are Recycled?

The most important materials recycled as aggregates are reclaimed asphalt pavement (RAP) and recycled concrete aggregate (RCA). Other sources include building debris, fill and rock from excavations, nickel smelter slag, steel slag, shredded old tires, old sanitary porcelain, and broken glass. Sand and gravel that are used on streets for ice control are recycled by some cities.

RAP is a popular material in Oregon. It is a valued resource. A ton of RAP contains about $8 of aggregate and asphalt. Besides economizing on materials, road crews using RAP also save on disposal costs.

The old asphalt in RAP is brittle. It is an inferior substitute for fresh asphalt. Contractors correct this problem by blending in plenty of fresh asphalt. Typical mixes contain 15% and 20% RAP.

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[17] In 1993, the average active commercial mine produced 83,159 tons of aggregate.

[18] This assumes that the average landfill depth is 20 ft.

[19] According to Chuck Marck, Technical Director of Vulcan Materials Corp., 40 million tons of waste is produced annually from the repair and rehabilitation of pavements in the U.S. (*Stone Review*, August 1994, p. 24). Oregon's share in proportion to its road mileage is 633,000 tons.

Hot-mix asphalt plants that use RAP need special equipment for controlling emissions. Heating RAP is a smoky process. RAP is more commonly used in urban areas, where volumes are high enough to cover the costs of this added equipment.

Occasionally, road crews will resurface asphalt roads using in-place methods. They use either heat or mechanical means to remove the top layer of pavement. This RAP is then mixed with new materials and put back down in a continuous process. RAP makes up over 90% of the aggregate used. Because of the high RAP content, additives may be needed so that the new pavement has the desired characteristics.

Many paving companies and public road departments use RAP whenever they can. Some customers, however, question its durability. Specifications for paving projects often restrict or even prohibit the use of RAP. Sometimes these are justified, but at other times they are not.

Besides being used in pavement, RAP is an excellent substitute for base rock. No special equipment is needed for this end use.

Recycled concrete aggregate (RCA) is recovered from old concrete pavement, masonry block, and torn-down buildings. Old concrete is usually found mixed in with other construction debris. Steel, copper, wood, bricks, and other materials are separated from the concrete. Some of these materials are quite valuable. Once they are removed, portable equipment is used to crush the old concrete into acceptable sizes. This processing is often prompted by high disposal costs for construction debris. Recycling reduces the volume of material sent to landfills.

RCA is a good substitute for crushed rock. It is not as valuable as RAP, however. While RAP contains usable asphalt, the cement in RCA cannot be recovered in its original form. RCA also is typically found in small quantities at any one site. It is most likely to be recycled in cities where there are markets for the product, large concrete structures, and high disposal costs.

Clean building debris is sometimes used as a substitute for virgin aggregate fill. This activity is driven mostly by the high disposal costs for building debris. For this reason, it is more common in urban areas. Debris from torn-down buildings may be used as fill on site, be trucked to other job sites, or be sent to old aggregate mines. Old mines that are in areas where real estate prices are high can be refilled with clean debris. Once filled, the recovered land may be used for a park or even as a building site.

Soil, sand, and rock removed from excavations can be used in place of virgin aggregate from mines. Excavated material that is used as fill elsewhere on a job site is called native fill. Technically, this is not considered recycling, since it is part of the process of site preparation, where natural materials are moved. Recycling does occur, however, if the excavated material is a waste product that could go to a landfill but is diverted for use at another construction site.

Various industrial and municipal wastes are recycled and used for aggregate. To be economical they must be clean and safe to the environment, come in large quantities, and have the physical properties of natural aggregate. Nickel smelter slag from the town of Riddle in Douglas County, Oregon, is a particularly good aggregate source.

Can We Find Ways to Replace Aggregate?

Aggregate is a difficult material to substitute because few of its alternatives are cost effective. However, all commodities, no matter how inexpensive, face some substitution. For aggregate, only a fraction of the total market is vulnerable to substitution. These cases tend to be limited to a few specific end uses and circumstances. In an individual case the savings are often small, but collectively they can be significant.

For most of its uses, virgin aggregate provides strength and bulk at a low cost. Only a few recycled materials and types of native fill share these features. Other substitutes lack some of the desirable characteristics of aggregate, but instead they provide other benefits.