Aggregate Resource Inventory of Kitsap County, Washington

Amy Rudko and Alex Steely

Washington Geological Survey, Olympia, WA

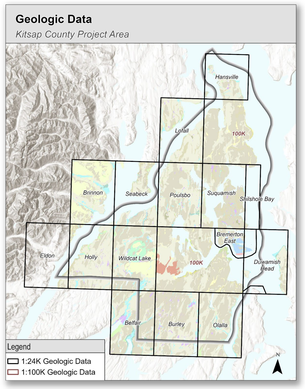
WASHINGTON STATE DEPT OF NATURAL RESOURCES
WASHINGTON GEOLOGICAL SURVEY

The WGS aggregate resources webpage
dnr.wa.gov/geology/aggregate-resources

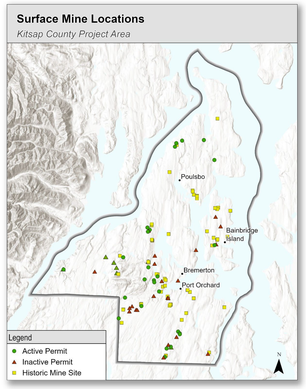
Why Map Aggregate?

- Washington State's Growth Management Act requires that counties and cities base land-use decisions related to Mineral Resource Lands on information provided by the Department of Natural Resources.
- Aggregate resources are often thought of as ubiquitous, however they are found only in specific geologic areas and their quality and quantity can vary.
- Aggregate resource maps help planners make geologically informed land-use decisions.

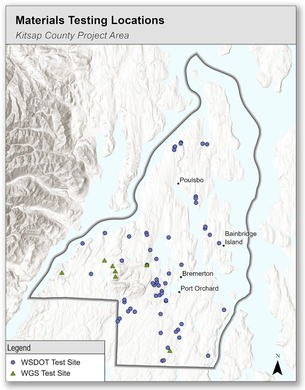
Compiling Data Sources



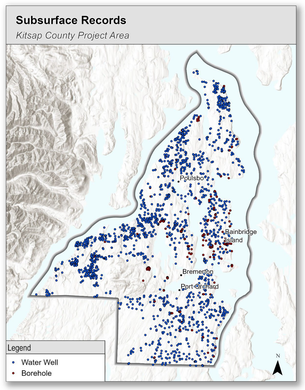
- *13 1:24,000-scale maps*
- *2 1:100,000-scale maps*
- *1 geomorphology map*



- *26 active permitted mines*
- *22 cancelled or terminated mine permits*
- *56 historic mine sites*



- *73 test results from WSDOT*
- *7 samples tested for this project*



- *2,029 subsurface records*

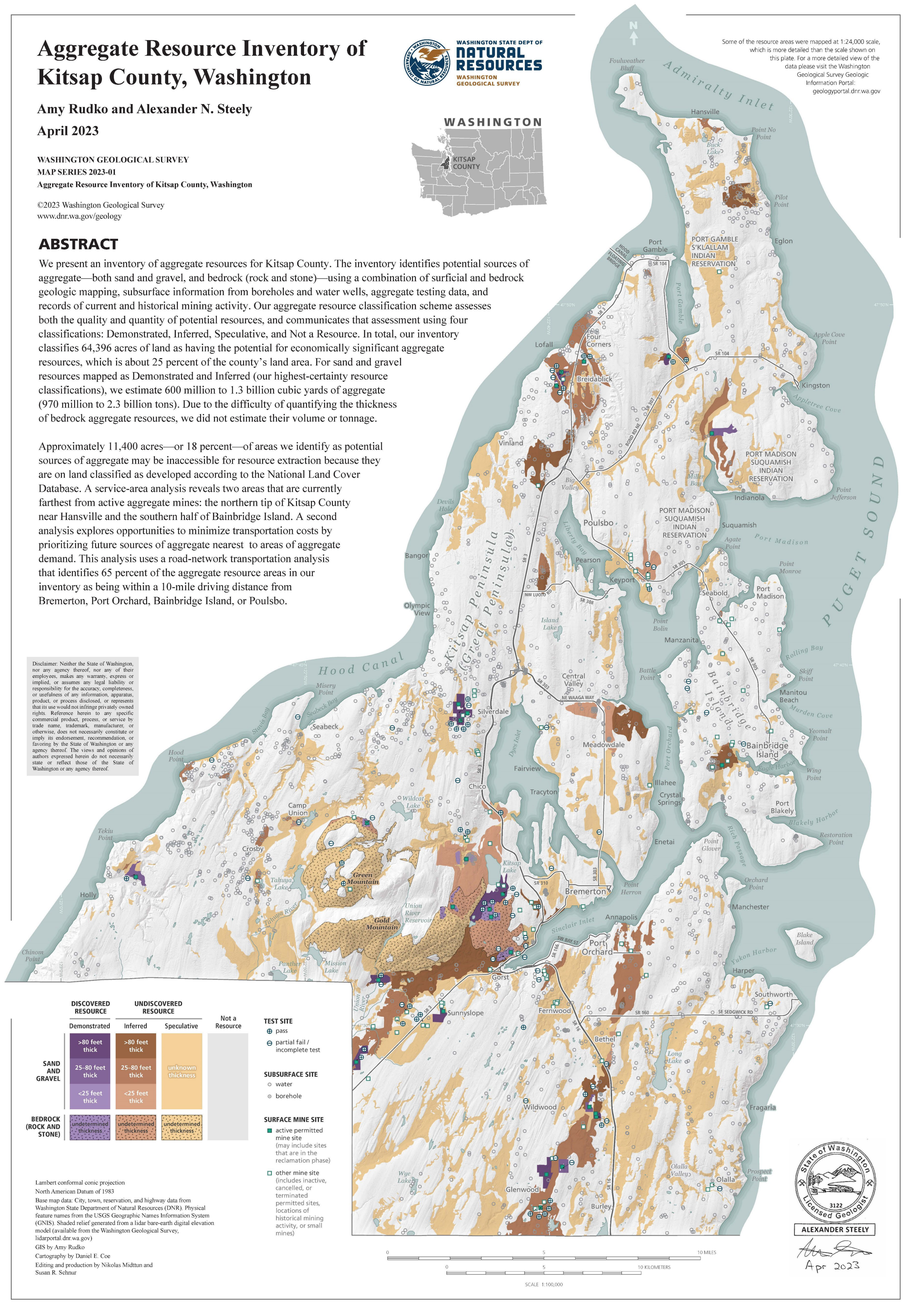
Classifying Resources

Holistic decision table describing the types, consistency, and quality of evidence that support each of the aggregate quality classifications (Demonstrated, Inferred, Speculative, and Not a Resource).

Resource-quality input data	More data available, data more consistent → Demonstrated	Inferred	Speculative	← Less data available, data less consistent: Not a Resource
Material description of sand and gravel or bedrock Sources: Geologic and geomorphic maps (1:24,000 to 1:100,000 scale), subsurface data, and other geologic descriptions when available	Material descriptions are typically consistent and indicate a good-quality resource* with minor, if any, material of lesser quality. Example: A 1:24,000-scale geologic map describes in detail a well-sorted gravelly glacial outwash deposit.	Material descriptions vary in level of detail and (or) indicate the resource quality varies and may include some minor material that is not of good quality. Examples: A 1:24,000-scale geologic map describes in detail a unit that contains mostly sand and gravel but also lenses of till, or a 1:100,000-scale geologic map describes a unit that generally contains sand and gravel.	Material descriptions vary in level of detail and (or) indicate the resource may include minor to moderate amounts of lower-quality material.* Example: A 1:100,000-scale geologic map describes a glacial ice-contact unit which may contain a mixture of good material (esker gravels) and low-quality material (silvery till).	Material descriptions available indicate material does not meet our aggregate resource material requirements.* Example: A 1:24,000-scale geologic map describes a poorly sorted glacial till with significant clay content.
Active permitted mining activity Sources: SMRP records of active mines	Typically intersects with or adjacent to active (permitted) aggregate mines or quarries.	Sometimes adjacent to active (permitted) aggregate mines or quarries.	Rarely near or adjacent to active (permitted) aggregate mines or quarries.	Rarely near or adjacent to active (permitted) aggregate mines or quarries.
Subsurface data (where available) Sources: Water-well logs, geotechnical borings	Subsurface data are typically available, well-located, evenly distributed, and indicate good-quality aggregate material throughout the resource area.	Subsurface data are typically available, but may be located with variable precision. Generally indicate good-quality aggregate material. Some records may indicate lower-quality material.	Subsurface data are sometimes available, located with variable precision, have uneven distribution, and (or) indicate variable quality aggregate material.	Subsurface data may or may not be available. Where available, data generally indicate material does not meet our aggregate resource material requirements.*
Other Mining activity (if available) Sources: SMRP records of inactive mines, USGS topo maps	Typically intersects with or adjacent to small mining operations, inactive (cancelled or terminated permit) aggregate mines or quarries, or historical mining activity.	Sometimes intersects with or adjacent to small mining operations, inactive (cancelled or terminated permit) aggregate mines or quarries, or historical mining activity.	Sometimes intersects with or adjacent to small mining operations, inactive (cancelled or terminated permit) aggregate mines or quarries, or historical mining activity.	Rarely intersects with or adjacent to historical or small mining operations. OR Sometimes intersects with or adjacent to previously reclaimed or cancelled permitted mines.
Aggregate testing data (where available)	Test results are sometimes available. Available results typically pass our testing thresholds.†	Test results are sometimes available, but may be inconsistent. Available results sometimes pass our testing thresholds.†	Test results are rarely available and often inconsistent. Available results sometimes pass our testing thresholds.†	Test results are rarely available and often inconsistent. Available results typically fail our testing thresholds† or are incomplete.
Consistency of evidence	Most to all data indicate a good-quality resource, rarely data may indicate lower quality material.	Most to some data indicate a good-quality resource; some data may indicate lower-quality material.	At least some data indicate a good-quality resource; some data may indicate lower-quality material.	Most to all data indicate that the material is not a good aggregate resource; rarely data may indicate a good-quality resource.
Criteria that all resource polygons must meet (Demonstrated, Inferred, and Speculative polygons)	(1) When subsurface data are available and indicate the presence of an overburden, it is typically <10 feet thick with a stripping ratio of 1.3 or better (the overburden should be no more than a third of the resource thickness). (2) Mapped polygon is larger than 1 acre and not too narrow (generally >200 feet across at its narrowest dimension).			Criteria (1) or (2) are not met.

* Good-quality sand and gravel resource: Material description indicates sand and gravel with little to no organic material, silt, or clay. These deposits are typically unweathered, generally stratified, moderately to well rounded, and well sorted. Good-quality bedrock resource: Material description indicates little to no weathering, little indication of physical or chemical alteration, and other details that correspond with strong and durable rock.

† We adopt the 2023 specifications for Hot Mix Asphalt (HMA) as our aggregate testing threshold: LA Abrasion values of <30% and Washington Degradation values of >30%.



Inventory Estimates

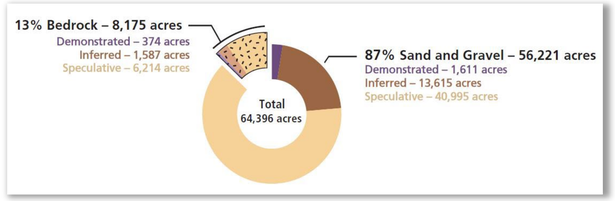
Area, volume, and tonnage estimates for potential aggregate resources broken down by type, classification, and filtered for developed land according to the National Land Cover Database.

	Area in acres	Low volume in millions of cubic yards	High volume in millions of cubic yards	Low tonnage in millions of tons	High tonnage in millions of tons
Sand and gravel					
Demonstrated	**1,611** *(1,419)*	**123** *(107)*	**142** *(125)*	**196** *(172)*	**256** *(225)*
Inferred	**13,615** *(9,866)*	**485** *(361)*	**1,154** *(871)*	**776** *(577)*	**2,077** *(1,567)*
Speculative	**40,995** *(33,667)*				
Subtotal	**56,221** *(44,952)*	**607** *(468)*	**1,296** *(995)*	**972** *(749)*	**2,333** *(1,792)*
Bedrock/rock and stone					
Demonstrated	**374** *(362)*				
Inferred	**1,587** *(1,519)*				
Speculative	**6,214** *(6,200)*				
Subtotal	**8,175** (8,081)				
Total area of all aggregate resources					
Total	**64,396** *(53,034)*				

Bold = entire inventory
(Italics) = undeveloped areas only

"Aggre-Great" Sources

In Kitsap County, the most abundant source of aggregate comes from Vashon Stade glacial deposits.



Distribution of aggregate commodities and quality classifications of inventoried aggregate resources in Kitsap County.

Sand and Gravel sources

- Vashon Stade glacial outwash deposits (e.g. glacial fluvial systems, glacial deltas)
- Vashon Stade ice-contact and ice-marginal deposits (e.g. eskers, kettles and kames)
- Nonglacial alluvium

Glacial outwash channel deposits

Sorted aggregate stockpile sourced from glacial outwash

Exposure of outwash gravel at an active surface mine

Rock and Stone sources
(All from Crescent Formation)

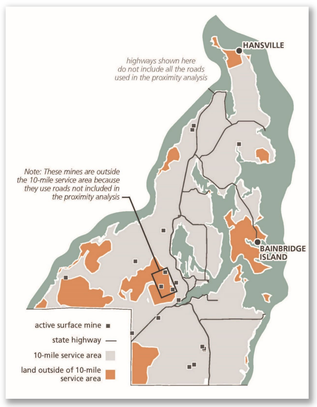
- Massive basalt
- Sheeted dikes of basalt and diabase
- Felsic intrusive rocks
- Leucogabbro and pegmatite

Hand sample of diabase sampled from Green Mountain, Kitsap County

Active bedrock quarry, mining rock of the Crescent Formation

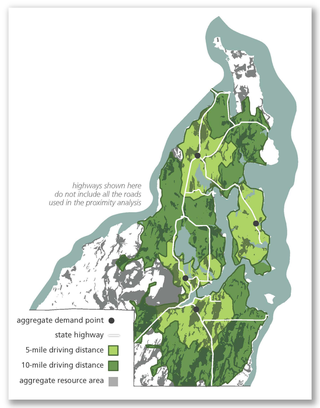
Exploring Distance to Market

TLDR: Rocks are heavy! For long hauls, the cost to transport aggregate can exceed the cost of the aggregate product that it's used for.



Analysis 1: Proximity analysis using currently active aggregate mines in Kitsap County and a 10-mile service area.

- *21% of the county falls outside of the 10-mile service area and may experience higher aggregate transportation costs. These areas include Hansville and the southern half of Bainbridge Island.*



Analysis 2: Proximity analysis showing a 5-mile and 10-mile outward service area from four points of aggregate demand: Port Orchard, Bremerton, Bainbridge Island, and Poulsbo.

- *65% of potential resources are within a 10-mile drive from selected cities*
- *35% of potential resources are within a 10-mile drive from selected cities*