

memorandum

Date: January 29, 2015

To: Paul Agrimis, Birch Bay Project Team

From: Jim Johannessen, LEG, MS and Adam Tullis, Coastal Geologic Services, Inc.

Re: **Birch Bay Drive & Pedestrian Facility, Task 4.1.3.2, Sediment Sources Study Results - FINAL**

Introduction and Purpose

This memorandum was generated as part of *Task 4.1.3.2 Study Sediment Sources*, to provide initial documentation of the availability and delivered cost of gravel and sand sediment materials required for the completion of the Birch Bay Berm beach nourishment project. The availability of the large quantities of nourishment sediment required for the new beach and berm complex is a critical element for planning ensuring sediment availability, project logistics and timing, and projected costs.

Potential nourishment sediment suppliers contacted included both local land transport (Whatcom County) and barge transport (barge loading facilities elsewhere in Puget Sound). The following is a report on the derived cost estimates provided by the suppliers that were contacted to facilitate future planning and cost estimating.

Methods

In order to complete the initial evaluation of gravel and sand sediment sources for the project, existing information from the previous phase of the project was utilized. The estimated material quantities used for this analysis are based on a 30% increase to the 2006 PWA team quantity estimates, from: *Birch Bay Shoreline Enhancement Phase 2A, Conceptual Cost Estimate*, dated December 11, 2007. The quantities were increased based on the current desire to provide a lower slope beach face with minimal maintenance needs, which will likely include some amount of additional nourishment volume in the southern end of the project to minimize maintenance.

Conversions can be made from cubic yards (CY) to tons using the following conversions (this should be verified in the next stage of work):

- Gravel: 1.45
- Gravelly sand: 1.7
- Sand: 1.4
- Average of 1.55 used for whole project at this stage

The quantities used for initial solicitation of costs were as follows:

- Gravel: 0.5-1.5" washed rounded gravel: 66,700 tons (46,000 CY)
- Gravelly sand: very coarse sand to 1.0" rounded gravel: 24,600 tons (14,470 CY)
- Sand: C33 ("concrete") sand or similar: 9,500 tons (6,760 CY)

Ferndale Ready Mix & Gravel and Cowden Gravel & Ready Mix are the largest providers of sand and gravel in Whatcom County, each owning multiple active pits with suitable sediment. Both of these providers have been successfully used multiple times by Coastal Geologic Services (CGS). These 2

providers were the sources contacted for the delivered cost of above gravel and sand sediment material quantities. Truck and trailer was the method of delivery that was discussed, with products to be dumped from the side of the road to the beach or backshore.

The barge delivery company JTC Inc. based in Tacoma was contacted to provide the delivered cost of gravel and sand sediment materials obtained from the Shelton gravel pit. JTC has extensive experience transferring these products to shallow beaches around the region, and has proven to be more reliable and cost effective than other barge companies in our experience. JTC can offload rapidly onto a beach using an extendable conveyor system which extends the considerable distance from the barge.

Results

Truck Delivery

Both Ferndale Ready Mix and Cowden assured us they have ample supply of gravel and sand going through at least the next 2-3 years. They were both aware that this project was coming along. CGS understands that some of the large volumes of gravel and sand material being used for rail projects and associated projects at Whatcom County oil refineries are from sources other than the ones discussed in this memo.

Gravel and sand of suitable beach quality are available from a number of pits in western Whatcom County. It appears completely feasible for truck and trailer delivery to the roadside without the need for backing up or back racking along the same route. Trucks would use one of several loops near the beach to allow for one-way travel only. Truck and trailer delivery would bring a minimum of 20 CY per truck trip, with some rigs able to bring 24 CY or so. This would be equivalent to 28-41 tons per truck trip depending on the material.

Roadway impact repair costs would occur with truck delivery. These costs were estimated and included in the estimated delivered beach sediment costs. Based on the estimated cost to repair the road surface along the Birch Bay Drive study area, the ESA team estimated an additional cost of \$7.50/ton would be needed. However, economic impact costs to the local Birch Bay businesses and community, which would result from the increase in traffic congestion with truck delivery, are not factored in. These costs are potentially considerable, but are highly dependent on project timing.

Barge Delivery

The DuPont Steilacoom and Shelton gravel pits are the only operating pits with direct load to barge facilities. Per JTC Inc., the DuPont Steilacoom (and Shelton) gravel pit operators Cal Portland, are not selling gravel out of the DuPont Steilacoom pit due to supply concerns and are sending orders to the Shelton pit. The Shelton Gravel Pit is located in Mason County in the furthest reaches of South Puget Sound, approximately 120 miles in a straight line from the beach in Birch Bay. This pit is much farther from the site and has more difficult barge access than the previously available DuPont Steilacoom gravel loading pier. The first leg out of the Shelton pit includes a shallow (in parts) run in moderately high tidal currents of narrow Hammersley Inlet. All of these factors add to the delivered cost.

The cost effective use of barge transport to deliver gravel and sand sediment materials obtained from the Shelton (or DuPont Steilacoom gravel) pit is dependent on the available depth to access the project site. Based on beach profiles and mapping, a barge would have to be able to reach very near the toe of the high tide beach at + 5.0 ft MLLW (+4 ft NAVD) to unload the material at the site through the use of a

conveyor system. The available draft depth for barge access was calculated as 4.0 ft based on a water elevation of +9.0 ft MLLW at Mean Higher High Water (MHHW). Due to this limited draft depth of 4.0 ft, a barge would have to either come in approximately one-third loaded or less (which may not be practical) or use access channels greater than 1,800 ft in length that would have to be dredged to the project site. Potential dredging has not been discussed with the resource agencies; therefore the associated permitting and mitigation issues are not currently defined, but this option is not deemed feasible due to permit and cost reasons.

The option of accomplishing barge delivery by transferring sediment from a fully loaded barge offshore of the sand flats to a smaller and also lightly loaded barge would also add considerable additional handling expenses as the barges to shore would have to be loaded on the order of one-quarter full to between into the beach at high tides.

Hydraulic pumping of nourishment sediment is a possible means to transfer the sediment to the beach. Hydraulic pumping would use a large horsepower pump connected to a length of large diameter plastic (poly pipe) to pump the material from the barge to the delivery site. The hydraulic pumping method is rarely used in Puget Sound as compared to the rest of the US. The only cases we know of that involved pumping are dredge projects, which pump dredged sediment out of basins onto barges for dewatering and off-site disposal or for beneficial reuse as beach nourishment, also with dewatering. CGS is not aware of any project in the Puget Sound region which has involved the dredging of the barge access in to a project site. Typically only the largest, and somewhat expensive, companies are set up to do or could put together a pumping arrangement.

With the very shallow low tide terrace and other project constraints, it was determined that the most feasible method of getting barge loaded sediment to the beach would be hydraulic pumping. After discussions with several barge operators in the region, consultation with a constructability expert in California, and having experience in hydraulic dredging in Puget Sound, the following are the anticipated elements for the Birch Bay beach nourishment using hydraulic pumping:

1. An additional barge in deeper water anchored or held in place by spuds set up with a minimum of 500 hp pump motor, and water intake
2. Possibly a booster pump halfway along the line
3. 1,800 ft of 12 inch or larger poly pipe attached together, all with floats and anchors attached
4. A shore crew to run the end of the pipe and building and maintaining required intertidal berms (oriented alongshore) for dewatering on the beach (during times of varying tides)
5. Possible maintenance of the pipe due to carrying coarse gravel
6. Possibly a large and repeatedly moved and re-anchored turbidity curtain to deal with the sediment load coming down the beach into marine waters
7. Potentially additional permitting and mitigation
8. Likely some/additional water quality monitoring

Hydraulic pumping would likely have the pipe approximately 1/4 full of sediment with the rest full of bay water, which will amount to a very large amount of water needing settling basin treatment before discharge to the beach. Additionally, pumping the large fractions of the gravel could require maintenance of the pipe during the project. The sediment feed rate would likely be slower at only 100-200 tons/hour, unless the other parts (pipe diameter, pump size) are scaled up more.

The additional barge in deeper water Hydraulic pumping of nourishment sediment would have the loaded barge using bay water to convey the sediment is a possible means to transfer the sediment from a barge in deeper water to the beach. This is a distance of approximately 2,000 FT to get to deep enough water to as much as 4,000 FT if eelgrass needs to be completely avoided by the barges.

We looked into the approximate depth requirements for a lightly loaded barge. This does not appear to be a feasible approach to get material to the beach by itself. Instead of loading 6,000 tons, if 3,000 tons only were loaded, a 5,000 plus ton barge would still draw 8 feet—and there is only approximately 4.0-4.5 feet of water to work with at the time of MHHW through most of the study area. Loading the barge only half way, for cost comparison, would save approximately 10% on towing costs but would require double the number of trips, which will almost double the towing portion of the numbers provided below.

Note that JTC has checked with possible sources of gravel and sand from Canada, and it is possible that sand could come from a source closer than Shelton. However, the gravel appears to be too angular at reasonable prices with Canadian sources. It has been the experience of CGS in doing several projects in British Columbia that rounded gravel, which comes from much more northerly mainland locations is often priced higher as compared to Whatcom County, and also that a host of cross border issues are quite problematic.

Estimated Costs

The following are the estimated delivered per ton costs to the project site, which were received from the contacted sources for the above beach sediment material quantities estimated for the Birch Bay berm project.

Ferndale Ready Mix & Gravel (Whatcom County pits-truck and trailer delivery):

Gravel:	\$16-17/ton (\$9-12/ton if 40% sand is allowable)
Gravelly sand:	\$8-9/ton
Sand:	\$9/ton

Cowden Gravel & Ready Mix (Whatcom County pits-truck and trailer delivery):

Gravel:	\$20.50/ton
Gravelly sand:	\$14.50/ton
Sand:	\$17.50/ton

JTC Inc. (Barge delivered from Shelton Pit; *does not include delivery from barge in deeper water to the upper beach; which is discussed above*):

Gravel:	\$20.00/ton
Gravelly sand:	\$11.50/ton
Sand:	\$17.00/ton

Applying the preliminary volumes outlines in the methods above, and using the lower cost supplier (Ferndale Ready Mix & Gravel) and the higher end of the ranges provided by that supplier, the following

is a preliminary list of delivered costs. Note this is prior to the 20% design level of design for beach nourishment quantities:

Ferndale Ready Mix & Gravel (Whatcom County pits-truck and trailer delivery):

Gravel:	$\$17 + \$7.50/\text{ton} \times 66,700 \text{ ton} = \$1,634,150$
Gravelly sand:	$\$9 + \$7.50/\text{ton} \times 24,600 \text{ ton} = \$405,900$
Sand:	$\$9 + \$7.50/\text{ton} \times 9,500 \text{ ton} = \$156,750$
Total:	$\$2,196,800$

The estimated costs for purchase and delivery of sediment by barge are below. The additional transfer step to get the material from fully loaded barges to the beach would involve the extra barge with hopper and pump facility, maintaining the floating line, and beach berms for dewatering would likely add \$8/ton or so to all products over the estimated barging costs listed below for simply getting the full barges to the adjacent deep water of Birch Bay. It is also understood that permitting may be more involved for this option and may require some mitigation if eelgrass is thought to be impacted (overall impacts to eelgrass would appear to be limited to potential anchoring in eelgrass and/or temporary shading).

Total costs for this level of planning for the barge delivery option would be:

JTC Inc. (Barge delivered from Shelton Pit) with additional pumping costs discussed above:

Gravel:	$\$20 + \$8/\text{ton} \times 66,700 \text{ ton} = \$1,867,600$
Gravelly sand:	$\$11.50 + \$8/\text{ton} \times 24,600 \text{ ton} = \$479,700$
Sand:	$\$17 + \$8/\text{ton} \times 9,500 \text{ ton} = \$237,500$
Total:	$\$2,584,800$

Preliminary Conclusions

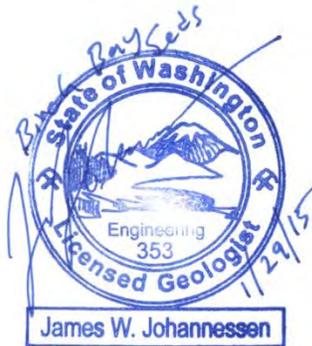
Based on the above costs for the beach nourishment sediment estimated for the construction of the Birch Bay berm it is likely that the locally obtained truck and trailer delivered materials appear to have approximately 20 percent lower costs than barge delivery. Barge delivery is very difficult at this location due to limitation of only 4.5-5.0 ft of water present near the beachface during times of normal higher high tides. The preliminary cost difference is on the order of one million dollars using the available information. Truck delivery is quite straight forward and predictable, and takes a lot of uncertainties that are associated with barge delivery off the table. Truck delivery may be most feasible if it is timed to start on the order of September 15 to avoid busy times of the year at Birch Bay.

Other project goals such as not causing too many impacts to businesses and public use of this portion of Birch Bay Drive and the beach area will be important to consider. Truck and trailer delivery of a grand total of 101,000 tons of sediment (pre 20% design level quantities only), using 36/tons per truck and trailer rig, would constitute approximately 2,800 round trips from the pits. The project will likely be constructed in stages and there are several routes which could be used for the south and north ends which would keep trucks away from the busiest part of Birch Bay Drive for work in those portions of the site. However, this method could cause a moderate to significant amount of disruption if not completed

all in the off season. Truck and trailer delivery could also cause a moderate amount of pavement damage and would certainly impact businesses and the public. For this reason, we propose to keep both delivery methods open as options for additional analysis at this early stage of design and planning.

Both large gravel pit companies contacted stated they can meet the needed quantities with adequate notice. Gravel and sand should continue to be available from the Shelton pit.

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