Seawall Options

Option	Method	Cost	Unit	Seismic Resistance	Description	Pros	Cons	Construction Cost	Maintenance Cost	Effective Life	Constructability	Disruption	Regulatory Issue	Wall Capacity	Appearance	Total	Ranking
								WF 2	WF 1	WF 3	WF1	WF 1	WF 1	WF 2	WF 1		
Boise Wall A	Tieback Wall	$4,277	LF	Yes	Install new precast concrete panels in front of the existing wall on top of existing footing. Panels would be held in place with tiebacks. TIebacks would be angled down at approx. 20 degrees and be long enoughto reach the non-liquifiable dense sands starting at approx. 12 to 17 ft below grade.	1) Minimal disruption to residents, 2) relatively inexpensive, 3) can be designed for seismic load	Relies on existing footing and some potential issues need to be confirmed to ensure this option is viable	4	3	3	3	4	4	3	4	41	1
Boise Wall B	New cantilever sheet pile wall	$7,382	LF	Yes	Install a new steel sheet pile wall in front of the existing seawall with backfill between the new and existing walls.	1) Permanent solution that would completely replace the exisitng seawall with new construction more resistant to deterioration, 2) Could be designed for liquefaction , 3) Very typical seawall construction	1) Expensive, 2) Extends significantly beyond current footprint of wall and footing, 3) Could be relatively disruptive to homeowners. Would possibly include removing and replacing some decks, 4) large offset will require significant amounts of fill and 5) coverage of existing bottom could make permitting difficult.	1	4	5	3	1	2	5	4	41	1
Boise Wall C	New cantilever soldier pile wall	$7,037	LF	Yes	New soldier piles would be driven in front of the existing walls, panels would be placed between the piles and the gap between the existing wall and the panels would be flled.	1) Permanent solution that would completley replace the existing seawall with new construciton more resistant to deterioration 2) Could be designed for liqufaction	1) Expensive, 2) Extends outside current footprint of wall and footing, 3) Disruptive to homeowners. Driving piles wourld require cutting holes in decks that overhang the walls, 4) Pile driving is likely to be objectionable to homeowners and could lead to liquefaction and settlement, 5) If not carefully constructed, lagging could be uneven and/or allow leaks of backfill which would be unattractive	3	3	4	3	2	2	4	3	39	3
Boise Wall D	New soldier piles tied to existing pilasters	$4,050	LF	No	Similar to Option C, but because the piles would be secured to the existing footings and pilasters, the wall could be constructed entirely below the decks. The piles would be H beams - most likely stainless steel - and would be secured at the base and near the tieback elevation.	1) New panels functionally replace the existing panels, which are the hardest and most expensive part of the panel system to protect, 2) Relatively quick to install, 3) Required pile size much smaller that for the cantilever option, 4) Low level of disruption	1) Expensive, but likely less so than for the cantilever option, 2) Does not do anything to protect the pilasters or footings, but still relies on them, 3) Covers, but does not fully protect the existing wall, and hides it from inspection, 4) Does not address seismic vulnerability	3	3	3	3	3	3	1	3	32	5

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								WF 2	WF 1	WF 3	WF1	WF 1	WF 1	WF 2	WF 1		
Boise Wall E	Concrete pilaster jackets and panel facing	$4,000	LF	No	This is the method proposed in Phase C of previous work. Consists of a new concrete jacket around the pilaster and a new approximately 4" thick concrete facing on the panels. Surface preparation would consist of chipping with handheld tools to remove loose concrete. Replace with a low-permeability concrete suitable for marine environment. Pilaster repair also the same as the Phase C work	1) Creates a barrier layer limiting seawater penetration to the existing concrete, slowing the alkalia silica reaction (ASR), 2) Reinforcing in pilaster jackets and panel facings will resist expansive forces from continuing ASR, 3) Existing jackets done for previous repairs appear to be surviving well, 4) Conventional construciton allows for a large pool of potential contractors, 5) Separates repairs of pilasters and panels, so pilasters can be prioritized	1) Existing reinforcing may continue to corrode, 2) Extension of design life unknown, 3) Does not address seismic vulnerablility	2	3	4	4	3	4	1	4	39	1
Boise Wall F	FRP pilaster jackets and panel facing	$3,850	LF	No	Similar to Option A, but uses fiberglass pilaster jackets and panel facings (FRP) with epoxy resin instead of concrete. Pilaster casings would be U-shaped and would need to be held in place by bolting to the faces of the panels on either side of the pilaster. Panel facings would be secured to the exisitng concrete using anchors. Concrete would be hydroblasted to a depth of 1 to 1-1/2 inches plus any loose concrete	1) Creats a barrier layer limiting seawater penetration to the existing concrete slowing the ASR and reinforcement corrosion, 2) FRP jackets will resist expansive forces from continuing ASR on front face of pilaster, 3) Lighter weight and easier handling may allow use of smaller equipment, 4) Separates repairs of pilasters and panels so that pilasters may be prioritized.	1) Limited number of manufacturers for FRP casings, 2) U-shaped casings not a typical application of FRP, 3) Likely to be more expensive than concrete repairs, 4) Existing reinforcings may continue to corrode, 5) Extension of design life unknown, 6) Does not address seismic vulnerability, 7) Hides walls from inspection	2	3	4	4	3	4	1	4	36	3

Seawall Options

Option	Method	Cost	Unit	Seismic Resistance	Description	Pros	Cons	Construction Cost	Maintenance Cost	Effective Life	Constructability	Disruption	Regulatory Issue	Wall Capacity	Appearance	Total	Ranking
								WF 2	WF 1	WF 3	WF1	WF 1	WF 1	WF 2	WF 1		
Boise Wall G	Riprap stabilization	$10,094	LF	No	Install large rock on the outer face of the walls to stabilize them. Height and angle of fill would be such that the fill would be stable on its own and not rely on the existing wall. Due to the soils, a conceptual level geotechnical analysis determined that even a slope of 3:1 would not provide the resistance requried to hold the existing groundlevel once the existing walls have lost capacity.	1) Essentially permanent, 2) Can be installed quickly, 3)Minimal engineering required	1) Would require docks be moved further away from the walls, which would require revisions to pier head line, 2) In narrower channels there would not be sufficient room, so might require elimination of docks, so could only be used on wider channels, 3) Feasibility depends on slope and depth of channel bottoms at base of walls. Limited information currently available, 4) Large encroachment on existing soft bottom, and significant excavation will cause permitting diffficulty	2	5	5	2	1	1	4	2	38	2
Boise Wall H	Epoxy crack injection of panel faces	$440	SF	No	In lieu of replacing panels, epoxy injection of cracks could be considered. The key caution with this option is that if conditions that caused the initial cracking are still active, the concrete is likely to crack again adjacent to the repaired cracks. This option will probably not do anything to repair or protect the panel surface from futrther deterioration, so this is probably not viable where there is a significant degradation of the panel surface. If selected, this option should be combined with pilaster jacketing from Option A or B. Epoxy injection is not considered to be an adequate repair for any but the most lightly deteriorated panels	1) Relatively low cost, 2) Quick to accomplish	1) Does not repair the concrete surface or protect it from further deterioration, 2) Does not strengthen the wall panels, 3) Concrete may crack again adjacent to the repaired cracks in a short amount of time, 4) Extension of service life is uncertain and will depend on extent, locations and severity of re-cracking, 5) Repair locations will be obvious and maybe considered unattractive, 6) Does not address seismic vulnerability	5	1	2	5	5	5	0	1	33	4
Boise Wall I	Stainless steel reinforcing straps	$6,800	EA	No	After removing loose concrete, stainless steel straps would be set on a thin bed of epoxy mortar and bolted to the exterior face of a pilaster or panel parallel to the primary reinforcement. The straps would serve as external reinforcing to replace corroded rebar in the concrete. Does not repair or replace existing rebar and the concrete around the straps will continue to detriorate	1) Can be installed quickly with minimal mobilization, 2) Straps could be prefabricated for use in emergency situations	1) Does not do anything to slow concrete degradation, 2) Continuing damage to concrete around straps will eventually reduce their effectiveness, 3) Extension of design life unknown, but may be short, 4) Does not address seismic vulnerability	5	1	1	5	5	5	1	1	32	5

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Option	Method	Cost	Unit	Seismic Resistance	Description	Pros	Cons	Construction Cost	Maintenance Cost	Effective Life	Constructability	Disruption	Regulatory Issue	Wall Capacity	Appearance	Total	Ranking
								WF 2	WF 1	WF 3	WF1	WF 1	WF 1	WF 2	WF 1		
Zurn Wall J	Tieback Wall	$4,155	LF	Yes	Same as for the Boise walls, but with wider footing with two lines of parallel piles makes geotechnical issues less likely to preclude this option. Install new precast concrete panels in front of the existing wall on top of existing footing. Panels would be held in place with tiebacks. TIebacks would be angled down at approx. 20 degrees and be long enoughto reach the non-liquifiable dense sands starting at approx. 12 to 17 ft below grade.	1) Minimal disruption to residents, 2) relatively inexpensive, 3) can be designed for seismic load	Relies on existing footing and some potential issues need to be confirmed to ensure this option is viable	4	3	3	4	4	4	3	4	42	1
Zurn Wall K	New cantilever sheet pile wall	$7,382	LF	Yes	Essentially the same as for the Boise Walls. Install a new steel sheet pile wall in front of the existing seawall with backfill between the new and existing walls.	1) Permanent solution that would completely replace the exisitng seawall with new construction more resistant to deterioration, 2) Could be designed for liquefaction , 3) Very typical seawall construction	1) Expensive, 2) Extends significantly beyond current footprint of wall and footing, 3) Could be relatively disruptive to homeowners. Would possibly include removing and replacing some decks, 4) large offset will require significant amounts of fill and 5) coverage of existing bottom could make permitting difficult.	1	4	5	3	1	2	5	4	41	2
Zurn Wall L	New cantilever soldier piles and panels	$7,037	LF	Yes	Essentially the same as for the Boise Walls	1) Permanent solution that would completley replace the existing seawall with new construciton more resistant to deterioration 2) Could be designed for liqufaction	1) Expensive, 2) Extends outside current footprint of wall and footing, 3) Disruptive to homeowners. Driving piles wourld require cutting holes in decks that overhang the walls, 4) Pile driving is likely to be objectionable to homeowners and could lead to liquefaction and settlement, 5) If not carefully constructed, lagging could be uneven and/or allow leaks of backfill which would be unattractive	3	3	4	3	2	2	4	3	39	3
Zurn Wall M	Remove and replace concrete facing	$2,900	LF	No	Method proposed in Phase C of the previous work. Approx. 4" of concrete along with any loose material would be removed and replaced with new pnematically applied (shotcrete) low-permeability marine concrete proportioned following ACI reccomendations for limting susceptiblity to ASR and marine attack. A modification to the previous work would be to install dowels into the existing concrete to protect against delamination of the new concrete from the existing if the expansion due to ASR continues.	Creates a barrier layer limiting seawater penetration to the existing concrete slowing the ASR and reinforcement corrosion	1) May require shoring of the wall until the new concrete has cured, 2) Extension of design life unknown, 3) Does not address seismic vulnerability	3	4	4	3	3	4	1	5	39	2

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								WF 2	WF 1	WF 3	WF1	WF 1	WF 1	WF 2	WF 1		
Zurn Wall N	New concrete facing	$2,600	LF	No	Similar to Option I, but the concrete removal would be limited to loose material and the new facing would extend further out than the existing concrete. Because it would be a thicker layer of concrete, the new concrete could be formed and placed conventionally	Creates a barrier layer limiting seawater penetration to the existing concrete slowing the ASR and reinforcement corrosion	1) May require shoring of the wall until the new concrete has cured, but less likely than with Option I, 2) Extension of design life unknown, 3) Does not address seismic vulnerability	4	4	4	4	4	4	1	4	42	1
Zurn Wall O	Concrete buttresses	$3,150	SF	No	Concrete buttresses would be added to the front of the wall and doweled into the face. The buttresses would utilize the existing reinforcing at the back face of the wall, but make the effective section deeper, increasing the strength of the wall. The buttresses would become the compressive element of the section, reducing the importance of the degrading front face of the existing concrete. They would be placed 6 ft on center and use the same design mix as Option J. Steel buttresses could also be used and bolted into the wall and foundation.	1) SImple construction, 2) Unlikely to require shoring, 3) Repairs to the face concrete between buttresses could be delayed since the demand on the concrete would be reduced	1) Does not protect existing concrete between buttresses, so deterioration of the wall face will continue unabated, 2) Deterioration could undermine the interface between the buttress and the existing wall, weakening the repair and shortening its effective life, 3) Continuing degradation of the wall face will be unattractive and could be concerning to residents, 4) Does not address seismic vulnerability	5	2	3	5	5	4	1	2	39	2
Zurn Wall P	Riprap stabilization	$10,094	LF	No	Same as for the Boise walls. Install large rock on the outer face of the walls to stabilize them. Height and angle of fill would be such that the fill would be stable on its own and not rely on the existing wall. Due to the soils, a conceptual level geotechnical analysis determined that even a slope of 3:1 would not provide the resistance requried to hold the existing groundlevel once the existing walls have lost capacity.	1) Essentially permanent, 2) Can be installed quickly, 3)Minimal engineering required	1) Would require docks be moved further away from the walls, which would require revisions to pier head line, 2) In narrower channels there would not be sufficient room, so might require elimination of docks, so could only be used on wider channels, 3) Feasibility depends on slope and depth of channel bottoms at base of walls. Limited information currently available, 4) Large encroachment on existing soft bottom, and significant excavation will cause permitting diffficulty	2	5	5	2	1	1	4	2	38	3