City of Oak Harbor
City Council Agenda Bill

Bill No. AB 5
Date: November 20, 2012
Subject: Wastewater Treatment Plant Field Study Results

FROM: **Cathy Rosen, Public Works Director**

INITIALED AS APPROVED FOR SUBMITTAL TO THE COUNCIL BY:
Scott Dudley, Mayor
Larry Cort, Interim City Administrator
Doug Merriman, Finance Director
Grant Weed, Interim City Attorney, as to form

PURPOSE
This agenda bill proposes adoption of a resolution related to expanding the boundaries of the Windjammer Vicinity to include adjacent (Freund) property.

On October 16, 2012, City Council directed staff to include the Freund property in field work proposed in Carollo Consultant Agreement Amendment #5 for the Wastewater Facility Plan. The attached presentation and reports are the results of that effort and are intended to assist City Council in their decision on whether the Windjammer Vicinity should be expanded to include the Freund property.

AUTHORITY
The City has authority under RCW 35A.11.020 to render governmental services including operating and supplying of utilities and municipal services commonly or conveniently rendered by cities or towns. The authority to provide sewer services is found in RCW 35.21.210 Chapter 35.67. Planning for those services as may be required under WAC 173-240 is included in this authority.

FISCAL IMPACT DESCRIPTION

Funds Required: none

Appropriation Source: n/a

SUMMARY STATEMENT
City Council approved an agreement with Carollo Engineers for the development of a facilities plan for a new wastewater treatment plant on August 4, 2010. With Carollo's assistance, the City and its citizens engaged in a two year long process to evaluate potential sites and technologies for a new wastewater treatment plant. On August 14, 2012, the City Council selected the Windjammer Vicinity as the site for a new MBR wastewater treatment plant.

On October 16, 2012, City Council approved contract Amendment #5 with Carollo Engineers to perform additional field work in the Windjammer Vicinity including an adjacent (Freund) property. The attached reports detail the findings of the field work. The intent of the field studies performed by

Carollo is to assist the City in determining the most suitable location for a new wastewater treatment plant (which requires between three to four acres) within the Windjammer Vicinity (which is over 50 acres).

In order to better understand cost and technical differences between the Windjammer Vicinity and the Freund property, Carollo has prepared the attached presentation comparing the following three siting options:

1. Windjammer Vicinity, Charrette (as presented at the August 14th City Council Meeting)
2. Freund Property
3. Windjammer Vicinity, Alternate (as presented at the August 14th City Council Meeting)

The three siting options were compared based on a number of factors that influence cost:

1. Land acquisition
   Based solely on assessed value, the Freund property is significantly lower in cost to acquire.
2. Architecture/aesthetics and need to blend with the surrounding environment
   Although there are clear differences between the sites, architectural costs are expected to be similar.
3. Special structure requirements
   Windjammer (Charrette) option requires special structural design to be constructed under what is expected to be the extension of Bayshore Drive. These costs are reduced with the other options.
4. Special geotechnical requirements (report attached)
   Northern and western portions of the Windjammer Vicinity are favorable from a geotechnical perspective. Deeper depth to solid soils, and higher groundwater were identified at the Freund property. These conditions will increase the cost for geotechnical design and construction.
5. Wastewater/effluent conveyance requirements
   Additional pipeline length increases cost of this item, and increases the risk of potential mitigation for cultural resources.
6. Sitework requirements, including:
   a. Clearing/demolition
   b. Stormwater management
   c. Flood protection
   d. Wetland mitigation

   Considering site-specific requirements, the Freund property has the highest cost due primarily to flood protection and wetland mitigation.

The field work indicates that all three of the proposed sites are feasible. Costs associated with each option can be found in the attached presentation. In general, technical differences between the three siting options result in offsetting costs. In addition, the Freund property presents additional risks associated with environmental permitting and flood protection. Staff recommends special consideration of these factors when selecting the final location for the facility.

STANDING COMMITTEE REPORT

This item was discussed at the November 1, 2012 Public Works Standing Committee meeting and at the November 13, 2012 Government Services Standing Committee meeting.

RECOMMENDED ACTION

A motion to either adopt Resolution 12-33 to proceed with the Facility Plan as directed by Resolution 12-17 or adopt Resolution 12-34 to incorporate the adjacent property and proceed with the TBL+ analysis and public process associated with including the adjacent property.

ATTACHMENTS

Resolution 12-33
Resolution 12-34
Attachment 1 - Technical/Cost Presentation
Attachment 2 - Survey Map
Attachment 3 - Environmental Memorandum
Attachment 4 - Geotechnical Memorandum

RESOLUTION NO. 12-33

A RESOLUTION OF THE CITY COUNCIL OF THE CITY OF OAK HARBOR, WASHINGTON, DIRECTING THE PREPARATION OF A WASTEWATER FACILITY PLAN WHICH WOULD PLACE A NEW WASTEWATER TREATMENT PLANT IN THE AREA IDENTIFIED AS "WINDJAMMER VICINITY" AS DEFINED BY CITY OF OAK HARBOR RESOLUTION 12-17.

WHEREAS, The City of Oak Harbor has determined that it requires additional capacity for wastewater treatment for the projected 2017 population forecast; and

WHEREAS, The flow to the Seaplane Base Lagoon Wastewater Treatment Plant has exceeded 85% of the plant capacity for more than three months in a row, triggering a need to prepare an Engineering Facility Plan to provide for future growth; and

WHEREAS, In recognition of this determination, the City of Oak Harbor is required by Wastewater Treatment NPDES Permit No. WA_002056-7 to prepare a Wastewater Facility Plan for future wastewater treatment capacity to meet future growth; and

WHEREAS, The City of Oak Harbor and its citizens have engaged in a two year long process to evaluate potential sites and technologies for a new wastewater treatment facility; and

WHEREAS, This process has resulted in a number of actions by the City Council, including the approval of various resolutions; and

WHEREAS, The approval of Resolution No. 12-17 on August 14, 2012 resulted in the selection of the vicinity around Windjammer Park east of Beeskma Drive as the location for a new MBR wastewater treatment plant; and

WHEREAS, this area is commonly referred to as "Windjammer Vicinity" in the context of the location for a new wastewater treatment plant; and

WHEREAS, subsequent to the approval of Resolution No. 12-17, City staff was approached by the owner of vacant property which is adjacent to area that was identified in Resolution No. 12-17 who suggested that the City consider this vacant property as a location for a new wastewater treatment plant; and

WHEREAS, on October 16, 2012, City Council approved Contract Amendment No. 5 with Carollo Engineers which directed Carollo Engineers to evaluate site-specific technical and cost differences associated with potentially locating a wastewater treatment plant on the proposed adjacent property compared to locating a wastewater treatment plant in the "Windjammer Vicinity" as defined by Resolution No. 12-17; and

WHEREAS, The comparative analysis outlined differences associated with wastewater and treated effluent conveyance, geotechnical and groundwater issues, environmental issues and other relevant technical considerations; and

WHEREAS, The analysis determined that it is feasible to construct a wastewater treatment plant on the proposed new site; and

WHEREAS, The construction costs to build a wastewater treatment plant on the proposed new site are similar to the construction costs to build a wastewater treatment plant on the Windjammer Vicinity site identified in Resolution 12-17 and the City will not realize a significant financial benefit by building a wastewater treatment plant on the proposed new site; and

WHEREAS, the proposed adjacent property has not received the same review and consideration by the public as the Windjammer Vicinity site has; and

WHEREAS, A public review process is necessary prior to including the proposed adjacent property in the Wastewater Facility Plan; and

WHEREAS, Modifying the boundaries of the Windjammer Vicinity to include this adjacent property and completing the associated public process will require an amendment to the contract with Carollo Engineers.

NOW, THEREFORE, THE CITY COUNCIL OF THE CITY OF OAK HARBOR, WASHINGTON, RESOLVES AS FOLLOWS:

That the benefits of modifying the Windjammer Vicinity to include the adjacent property for a wastewater treatment plant do not outweigh the additional costs associated with the public review process; and

That City staff and Carollo Engineers are directed to prepare a Wastewater Facility Plan to site a new wastewater treatment plant in the "Windjammer Vicinity" as defined in Resolution 12-17 adopted on August 14, 2012.

PASSED and approved by the City Council this _____ day of _____, 2012.

THE CITY OF OAK HARBOR

_____
Mayor

Attest:

_____
City Clerk

Approved as to Form:

_____
City Attorney

RESOLUTION NO. 12-34

A RESOLUTION OF THE CITY COUNCIL OF THE CITY OF OAK HARBOR, WASHINGTON, DIRECTING THE EXPANSION OF THE AREA IDENTIFIED AS "WINDJAMMER VICINITY" AS DEFINED BY CITY OF OAK HARBOR RESOLUTION 12-17 FOR THE LOCATION OF A NEW WASTEWATER TREATMENT PLANT.

WHEREAS, The City of Oak Harbor has determined that it requires additional capacity for wastewater treatment for the projected 2017 population forecast; and

WHEREAS, The flow to the Seaplane Base Lagoon Wastewater Treatment Plant has exceeded 85% of the plant capacity for more than three months in a row, triggering a need to prepare an Engineering Facility Plan to provide for future growth; and

WHEREAS, In recognition of this determination, the City of Oak Harbor is required by Wastewater Treatment NPDES Permit No. WA_002056-7 to prepare a Wastewater Facility Plan for future wastewater treatment capacity to meet future growth; and

WHEREAS, The City of Oak Harbor and its citizens have engaged in a two year long process to evaluate potential sites and technologies for a new wastewater treatment facility; and

WHEREAS, This process has resulted in a number of actions by the City Council, including the approval of various resolutions; and

WHEREAS, The approval of Resolution No. 12-17 on August 14, 2012 resulted in the selection of the vicinity around Windjammer Park east of Beeksma Drive as the location for a new MBR wastewater treatment plant; and

WHEREAS, this area is commonly referred to as "Windjammer Vicinity" in the context of the location for a new wastewater treatment plant; and

WHEREAS, subsequent to the approval of Resolution No. 12-17, City staff was approached by the owner of vacant property which is adjacent to area that was identified in Resolution No. 12-17 who suggested that the City consider this vacant property as a location for a new wastewater treatment plant; and

WHEREAS, on October 16, 2012, City Council approved Contract Amendment No. 5 with Carollo Engineers which directed Carollo Engineers to evaluate site-specific technical and cost differences associated with potentially locating a wastewater treatment plant on the proposed adjacent property compared to locating a wastewater treatment plant in the "Windjammer Vicinity" as defined by Resolution No. 12-17; and

WHEREAS, The comparative analysis outlined differences associated with wastewater and treated effluent conveyance, geotechnical and groundwater issues, environmental issues and other relevant technical considerations; and

WHEREAS, The analysis determined that it is feasible to construct a wastewater treatment plant on the proposed new site; and

WHEREAS, The construction costs to build a wastewater treatment plant on the proposed new site are similar to the construction costs to build a wastewater treatment plant on the Windjammer Vicinity site identified in Resolution 12-17; and

WHEREAS, the proposed adjacent property has not received the same review and consideration by the public as the Windjammer Vicinity site has; and

WHEREAS, A public review process is necessary prior to including the proposed adjacent property in the Wastewater Facility Plan; and

WHEREAS, City Council has determined that the proposed new site offers some unique opportunities and there is benefit in performing a TBL+ analysis and engaging the public regarding the proposed new site; and

WHEREAS, Modifying the boundaries of the Windjammer Vicinity to include this adjacent property and completing the associated public process will require an amendment to the contract with Carollo Engineers.

NOW, THEREFORE, THE CITY COUNCIL OF THE CITY OF OAK HARBOR, WASHINGTON, RESOLVES AS FOLLOWS:

That there are unique opportunities and benefits to modifying the "Windjammer Vicinity" to include the adjacent property for a wastewater treatment plant that warrant further review and consideration by the public; and

That City staff and Carollo Engineers are directed to bring forward an amendment to Carollo Engineers' contract to prepare a TBL+ analysis of the proposed new site and to engage the public in a review of the site.

PASSED and approved by the City Council this _____ day of _____, 2012.

THE CITY OF OAK HARBOR

_____
Mayor

Attest:

_____
City Clerk

Approved as to Form:

_____
City Attorney

CITY OF Oak Harbor
WHIDBEY ISLAND, WASHINGTON

Oak Harbor Facilities Plan

City Council Meeting

November 20, 2012

carollo
Engineers...Working Wonders With Water®

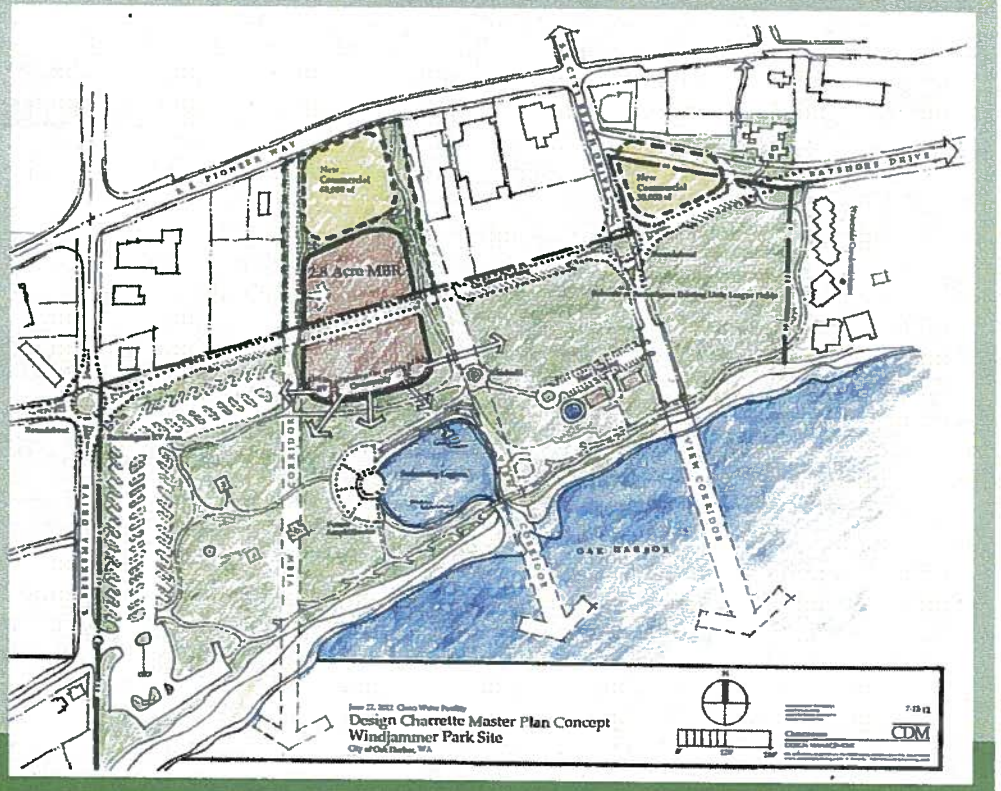
BHC CONSULTANTS

Tonight's Agenda/Objectives

1. Review scope and purpose of Amendment 5
2. Present results of field work completed through Amendment 5
   - Topographical Survey
   - Environmental Assessment
   - Geotechnical Borings
3. Summarize estimated cost impacts
4. Gain direction from Council on next steps:
   - Resolution 12-33: Complete Facilities Plan for Windjammer Vicinity as defined by Resolution 12-17
   - Resolution 12-34: Expand Windjammer Vicinity to include adjacent property and complete Facilities Plan

Resolution 12-17 (August 14, 2012)

- Proceed with Facilities Plan based on Windjammer Vicinity
- Minimize space impacts on Windjammer Park to the extent possible
- Continue public process:
  - Define the best location within the Windjammer Vicinity
  - Define layout and other desirable features based on the final location



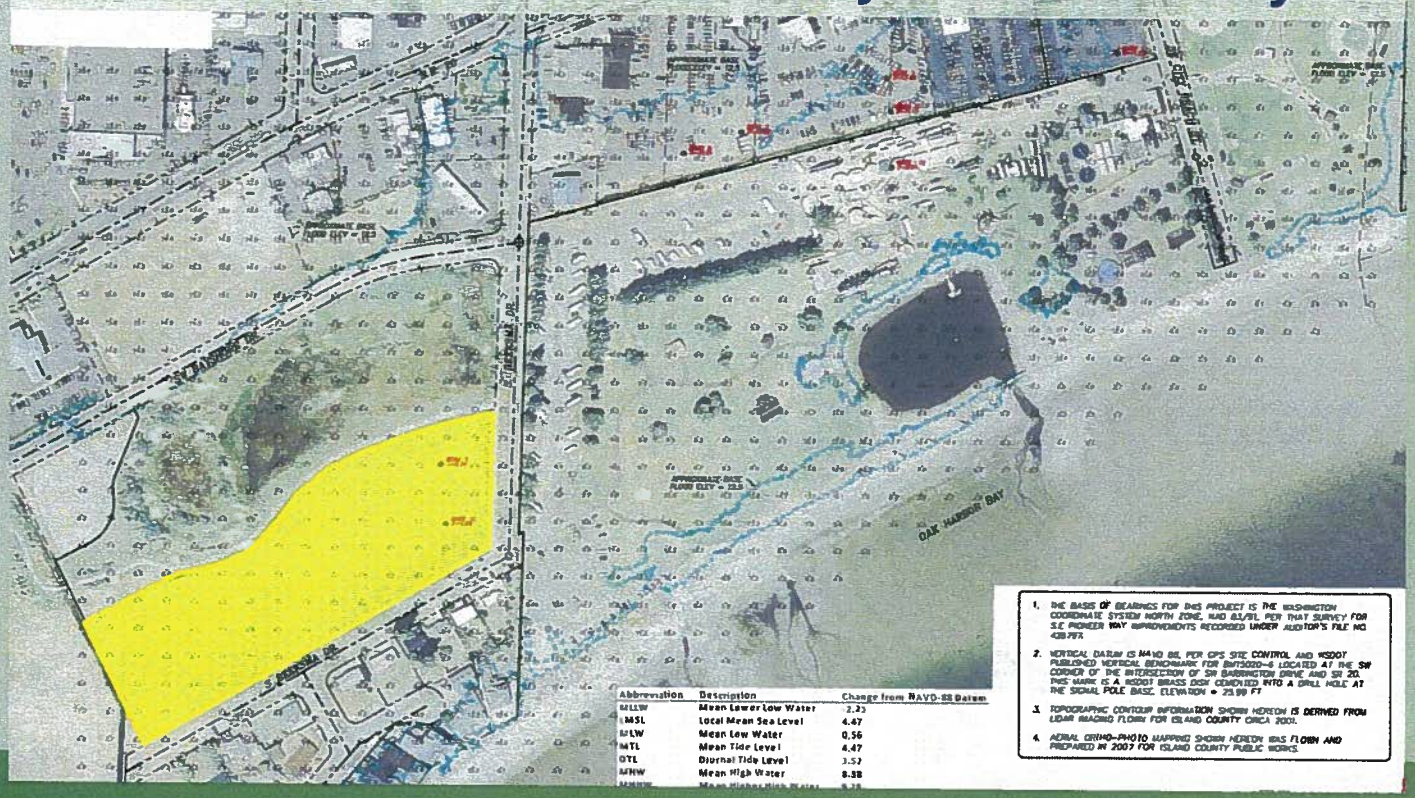
Amendment 5 Scope and Purpose

- Technical detail to help select the best location (3 to 4 acres) for the new WWTP
- Field work including:
  - Phase 1 topographical survey to establish elevations and flood protection requirements
  - Environmental assessment to better define permitting and wetland mitigation requirements
  - Geotechnical borings to characterize soils, better estimated design requirements and cost

October 16, 2012 City Council Direction

- Include adjacent property (Freund property) in scope of Amendment 5

Does Freund property provide technical/cost advantages relative to Windjammer Vicinity?

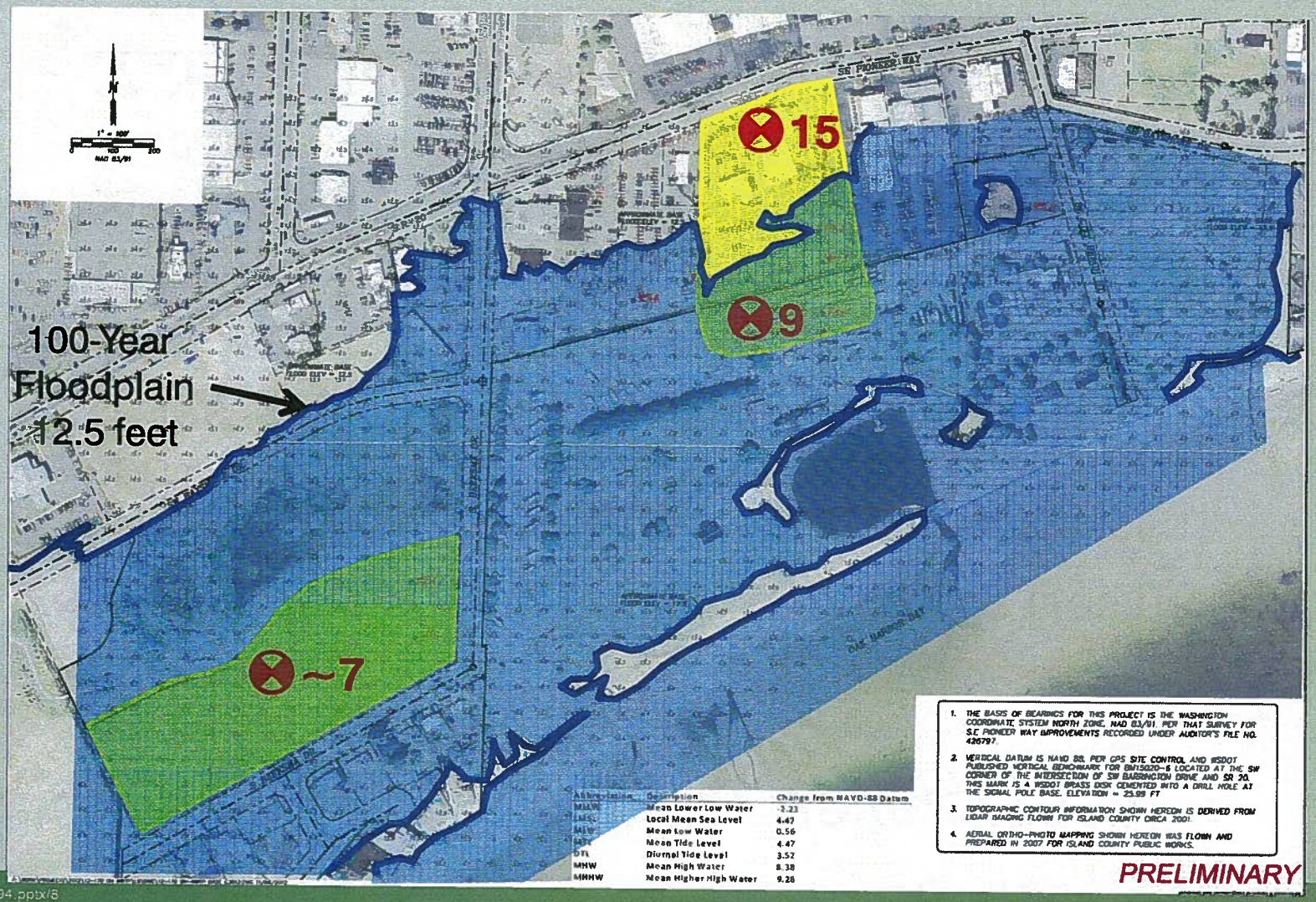


Amendment 5 Current Status

- Phase 1 survey work complete (Attachment 1)
- Environmental assessment completed based on October 30, 2012 site visit (Attachment 2)
- Geotechnical borings completed on October 30 and 31 (Attachment 3)
- Additional engineering analysis completed to compare three sites
  - Windjammer Vicinity (Charrette)
  - Freund
  - Windjammer Vicinity (Alternate)

Field Work Summary
Phase 1 Topographical Survey

100-Year Floodplain (El 12.5 NAVD 88)



Abbreviation	Description	Change from NAVD-88 Datum
MLLW	Mean Lower Low Water	-2.23
LMSL	Local Mean Sea Level	4.47
MLW	Mean Low Water	0.56
MTL	Mean Tide Level	4.47
DTL	Diurnal Tide Level	3.52
MHW	Mean High Water	8.38
MHHW	Mean Higher High Water	9.28

Regulations for Floodplain Development

- Orange Book (Criteria for Sewage Works Design, '08)
  - G2-1.5.2 Flood Protection: Locate unit processes above the 100-year flood/wave action or adequately protect from 100-year flood/wave action
- Oak Harbor Municipal Code 17.20
  - 17.20.190(2) Nonresidential Construction: Locate construction above the base flood elevation or floodproof structure to 1 ft above base flood elevation
  - 17.20.190(3) Critical Facilities:
    - Construction permissible if no feasible alternative
    - Lowest floor > 3 feet above base flood elevation

Summary of Flood Protection Requirements

- Portions (or all) of sites being considered lie within 100-year flood plain (12.5 NAVD 88)
  - Recommend elevating grade and/or structures to 13.5
  - Additional protection for "critical facilities" (e.g. electrical)
- Southern portions of Windjammer Vicinity sites must be elevated approximately 3 feet
  - Retaining wall or sloped fill
- Existing grade at Freund property is an average of ~6.5 feet below 100-year flood elevation
  - Retaining wall/levee
  - Fill site
  - New/improved access to site is needed
- 100-year flood elevation [+12.5] more conservative than Mean Higher High Water (MHHW) + sea level rise [approx. + 11.3]

Field Work Summary
Environmental Assessment



Summary of Environmental Assessment

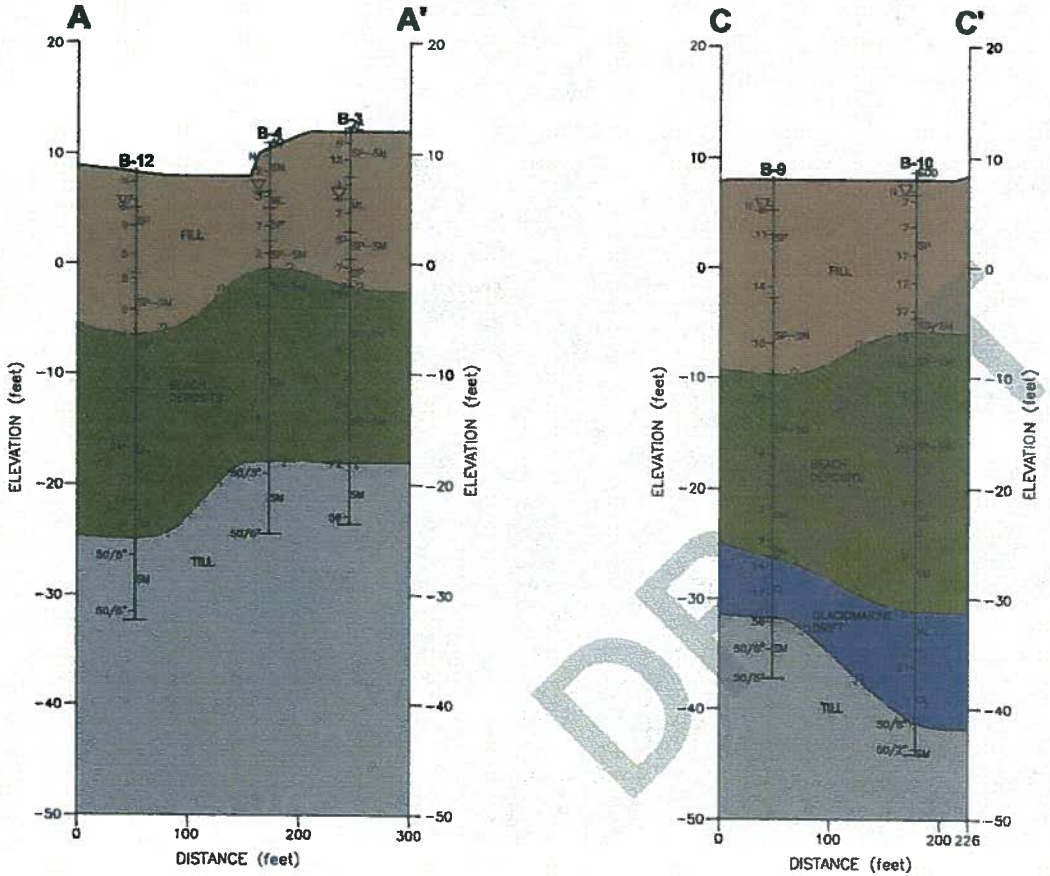
- Wetland ditches at both Windjammer (Charrette) and Freund sites
- Federal, state, Oak Harbor permit approvals required for wetland fill/buffer impacts
- Windjammer (Charrette) Site
  - Wetland ditch along southern boundary may be filled as result of project
  - Mitigation costs estimated between $150,000 and $275,000
  - Risk of delays and/or cost increases relatively low (limited tidal water connection)
- Freund Site
  - Wetland ditches along boundaries would be filled as result of project
  - Site adjacent to mitigation wetland; portion may be filled for access
  - Mitigation costs estimated from $400,000 to $800,000
  - Risk of delays and/or cost increases relatively high (tidal water connection; impact to previous mitigation wetland)

Field Work Summary
Geotechnical Assessment



Geotechnical Boring Site Plan

Geotechnical Cross Sections



EXPLANATION:

- B-4 — BORING NUMBER AND APPROXIMATE LOCATION
- 7 — BLOW COUNT
- SM — SOIL TYPE AT SAMPLE LOCATION
- ? — SOIL CONTACT
- GROUNDWATER LEVEL (DURING DRILLING)
- • — BLOW COUNT OVERSTATED

Horizontal Scale in Feet (100 0 100)

Vertical Scale in Feet (10 0 10)
Vertical Exaggeration: 10X

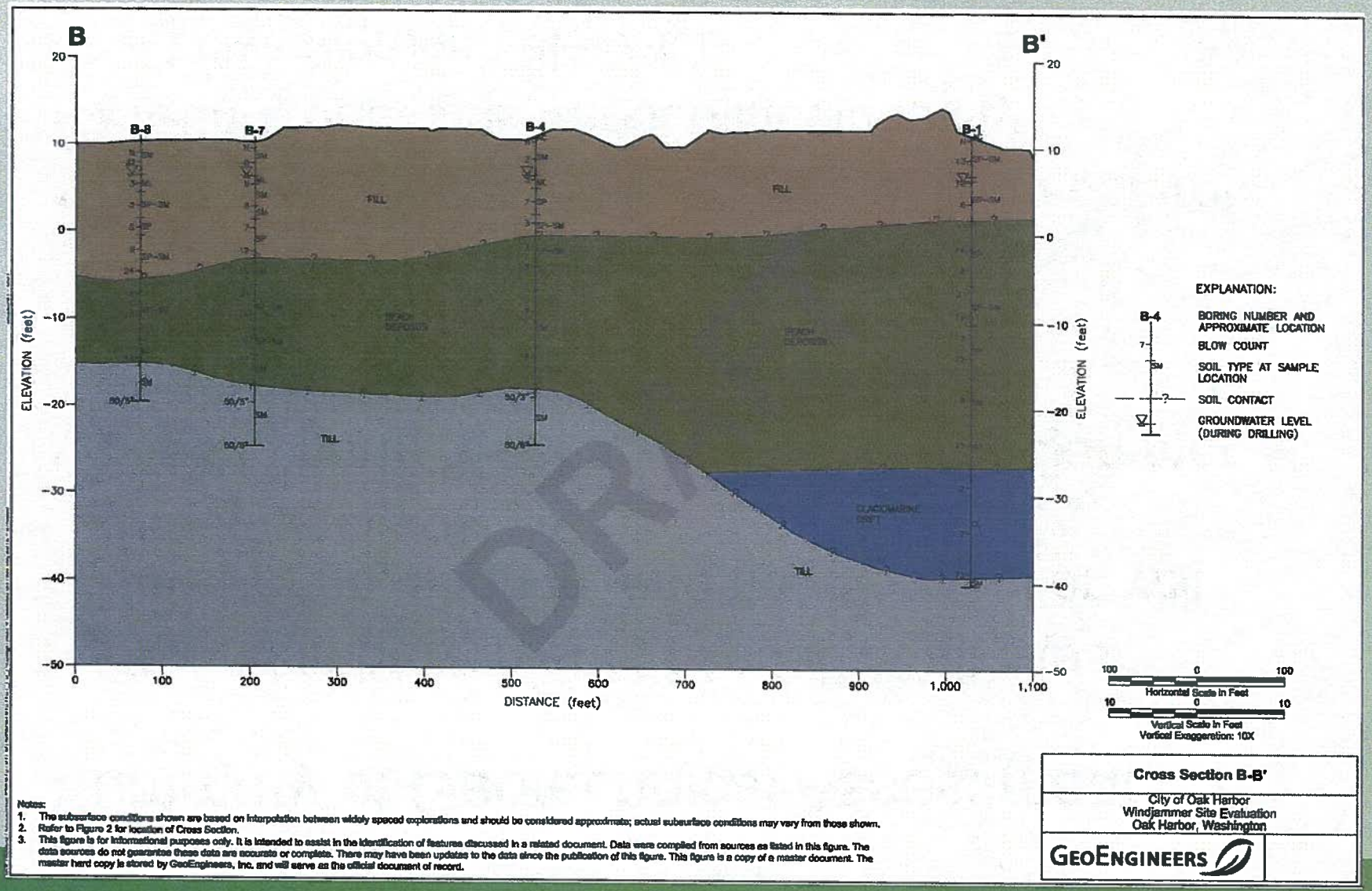
Cross Sections A-A' and C-C'

City of Oak Harbor
Windjammer Site Evaluation
Oak Harbor, Washington

GEOENGINEERS

Notes:
1. The subsurface conditions shown are based on interpolation between widely spaced explorations and should be considered approximate; actual subsurface conditions may vary from those shown.
2. Refer to Figure 2 for location of Cross Section.
3. This figure is for informational purposes only. It is intended to assist in the identification of features discussed in a related document. Data were compiled from sources as listed in this figure. The data sources do not guarantee these data are accurate or complete. There may have been updates to the data since the publication of this figure. This figure is a copy of a master document. The master hard copy is stored by GeoEngineers, Inc. and will serve as the official document of record.

Geotechnical Cross Sections



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Cross Section B-B'

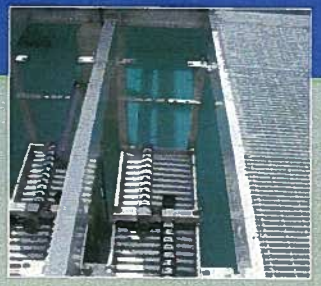
City of Oak Harbor
Windjammer Site Evaluation
Oak Harbor, Washington

GEOENGINEERS

Summary of Geotechnical Assessment

- Ground improvements needed at all sites
- Dewatering, shoring, and flood protection will also impact cost
- Sites to north, west and center of Windjammer Vicinity are preferred
  - Highest ground elevation
  - Shallowest to till (25 to 30 feet)
- Park site: deeper to till; additional flood control
- Freund, east sites most difficult/costly
  - Lowest ground elevation
  - Deepest to till (40+ feet)

Cost Comparison



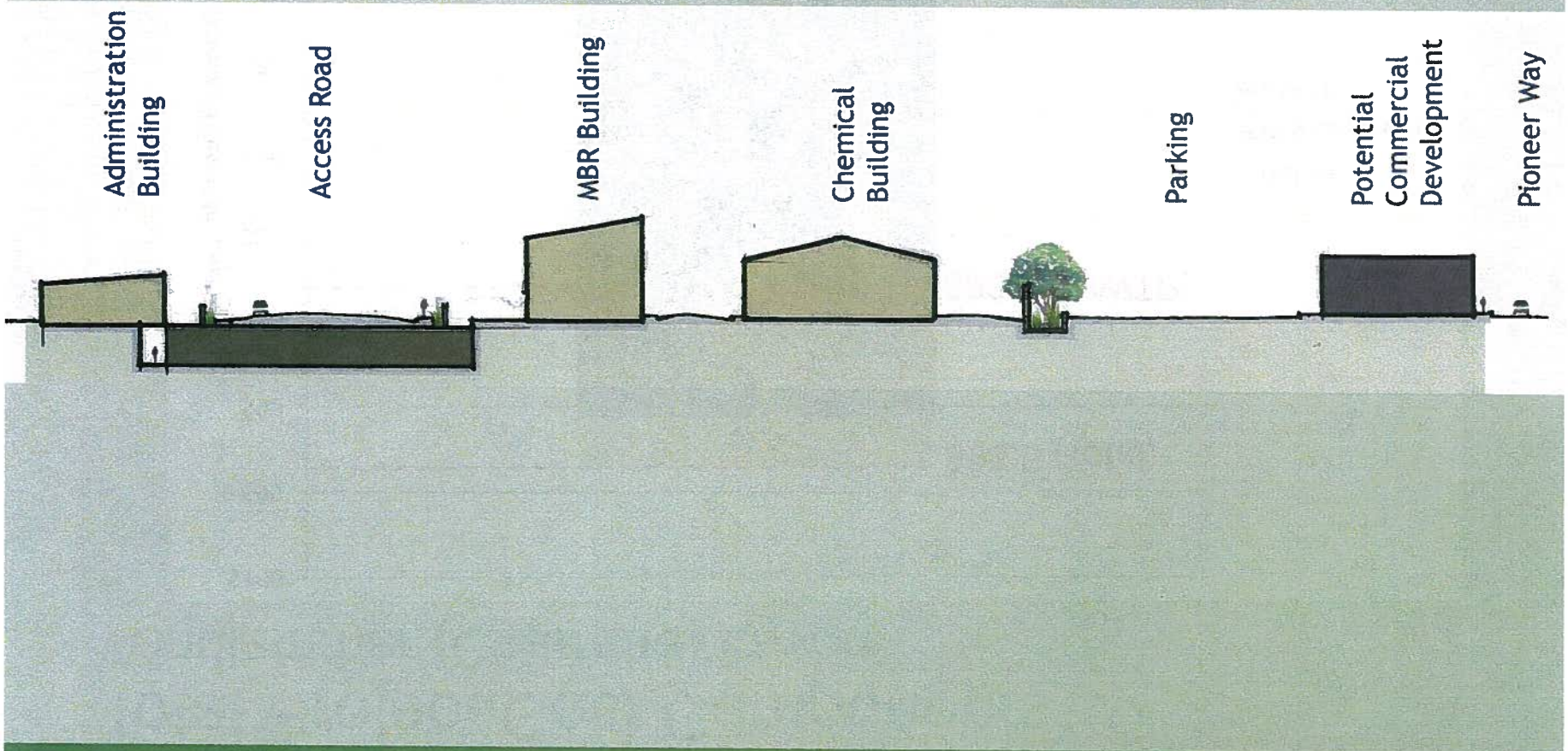
Windjammer Charrette Concept
Conceptual Plan View (August 14, 2012)

Building Key

1. Potential Community Building (cost not included)
2. Administration Building
3. Maintenance Shop
4. Headworks
5. Aeration Basins (buried beneath road)
6. Membrane Bioreactor (MBR) Building
7. Mechanical Building
8. Electrical Building
9. Chemical Building
10. Solids Building
11. Odor Control Building

North

Windjammer Charrette Concept
Conceptual Site Section View (August 14, 2012)



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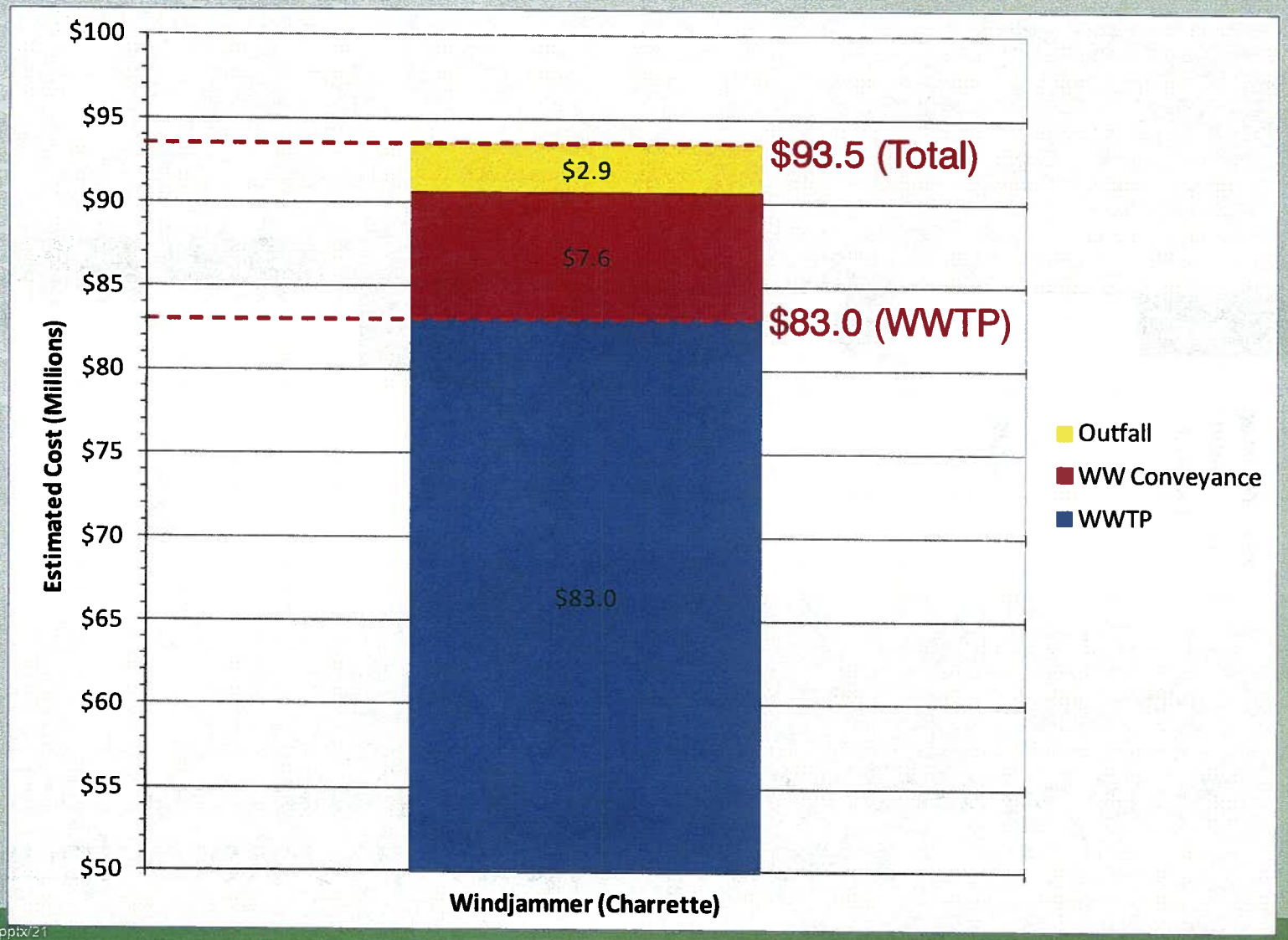
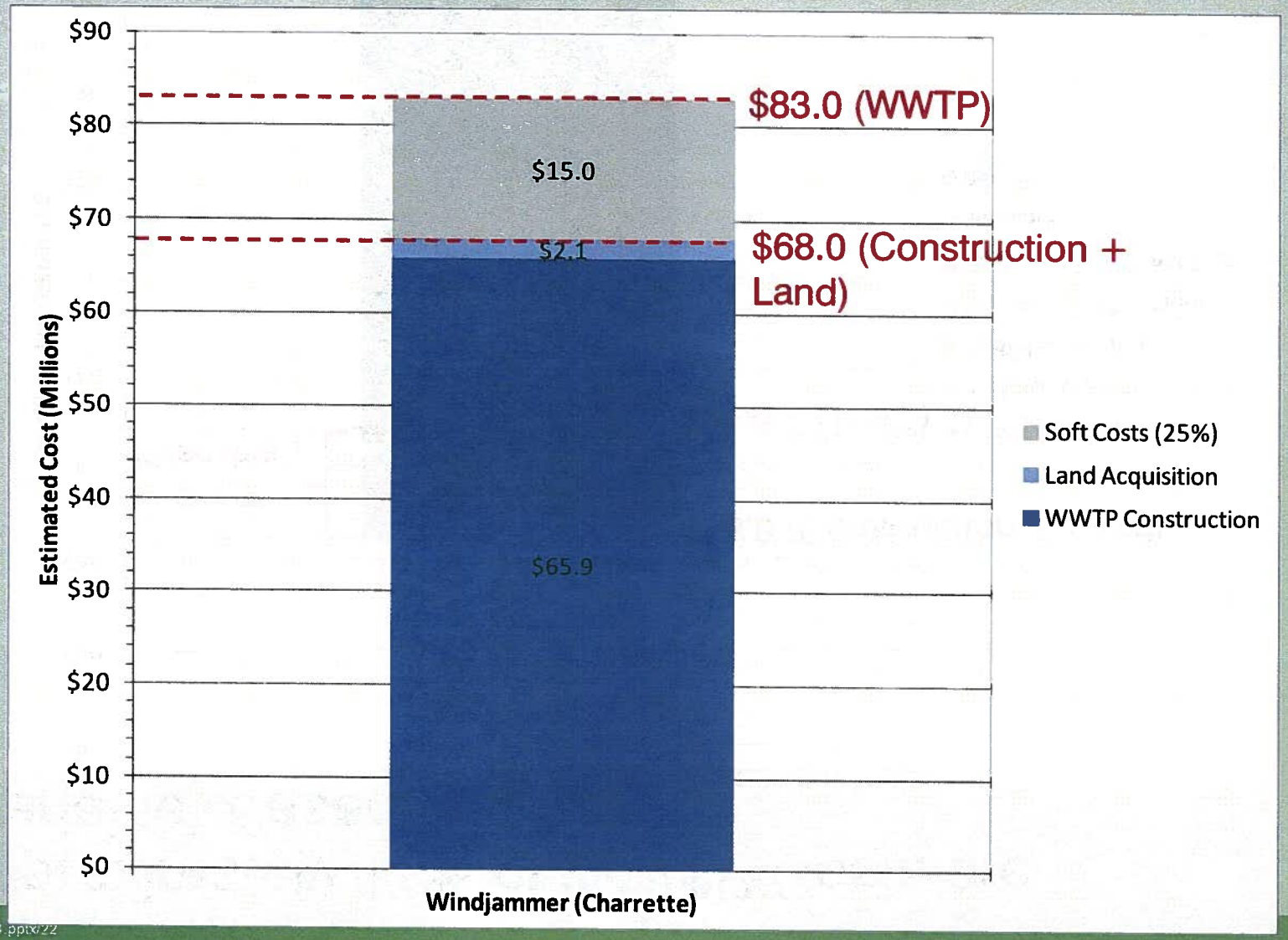
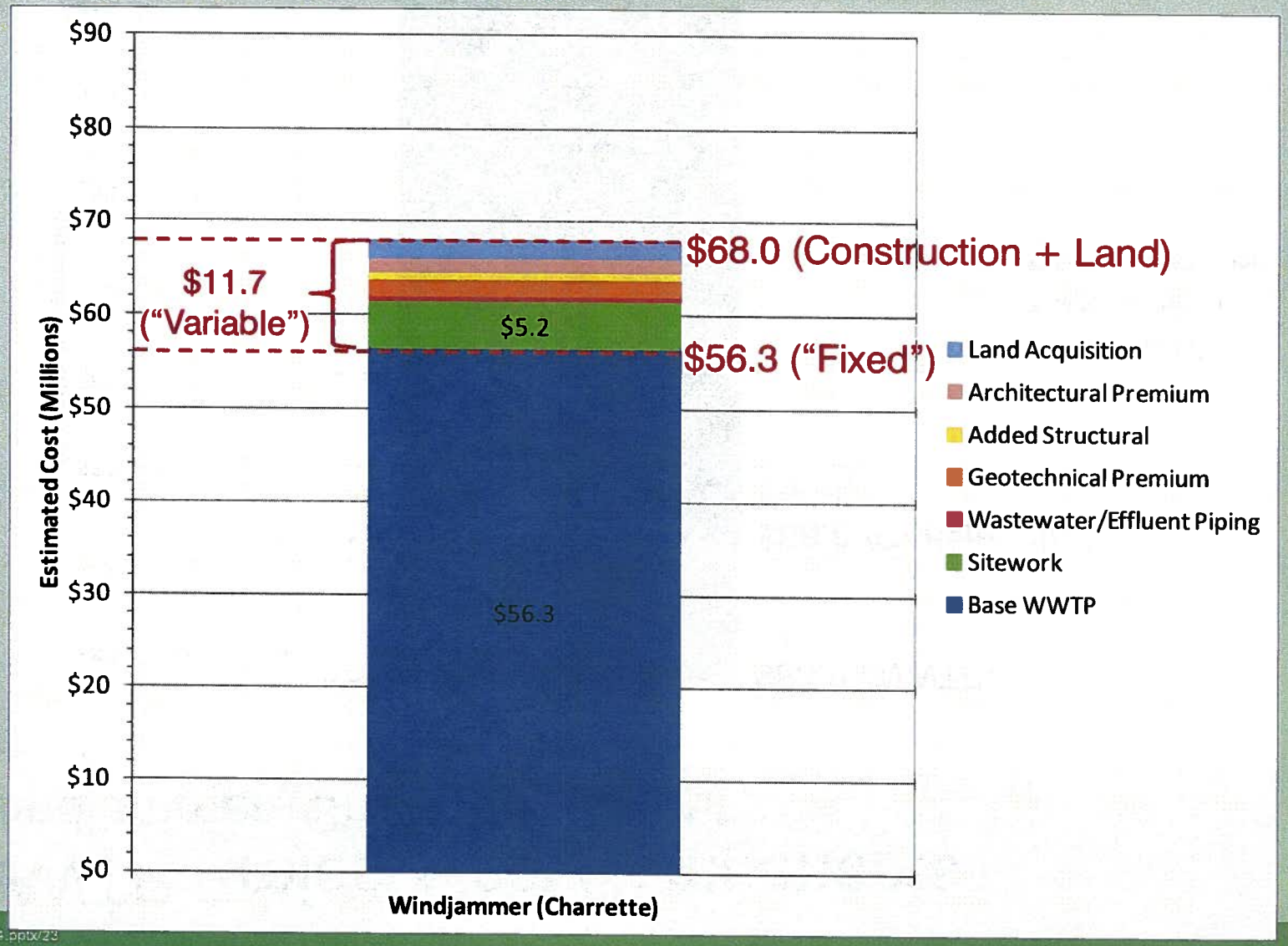
Total Project Cost Components
Windjammer (Charrette) Layout



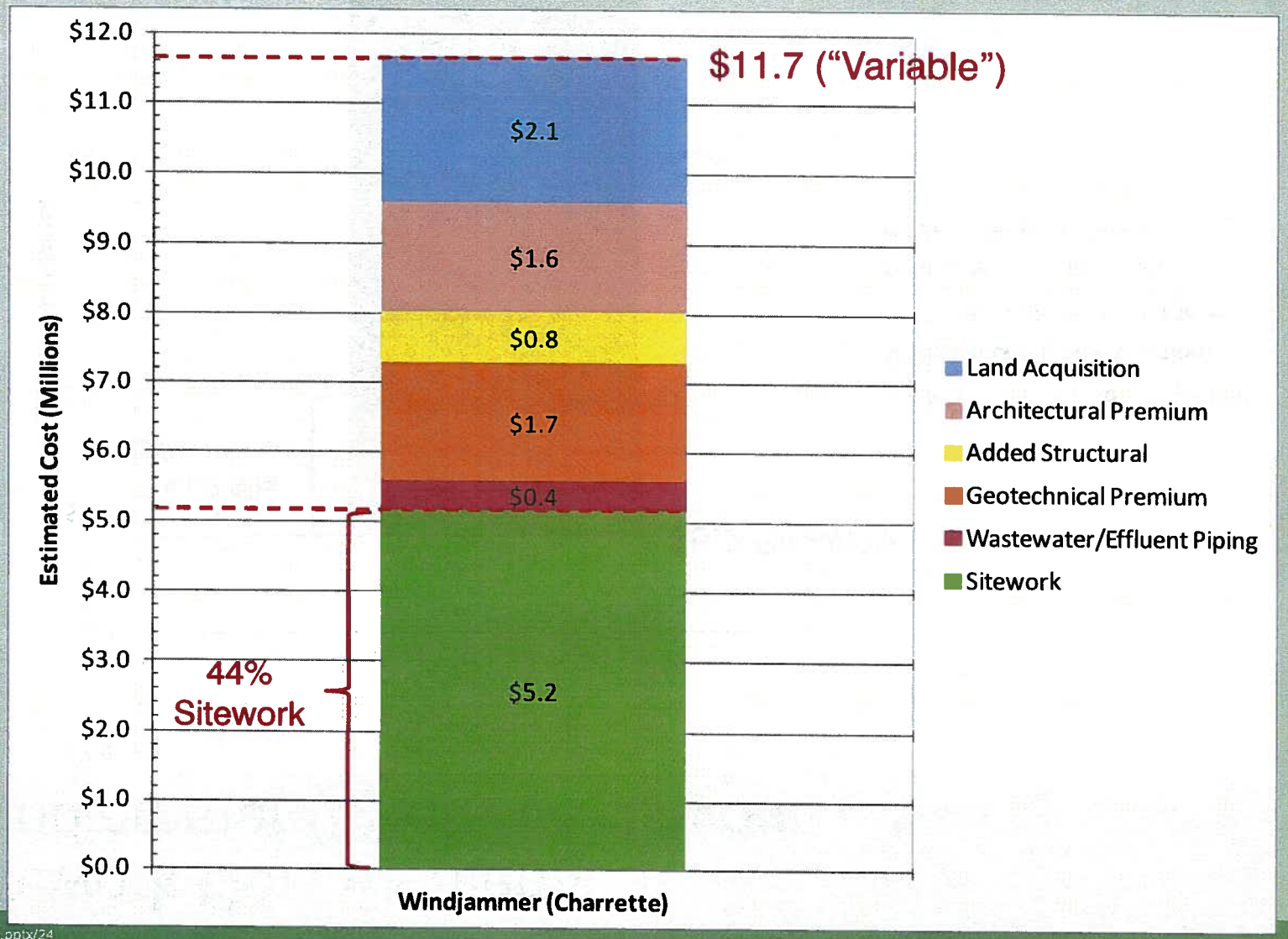
WWTP Project Cost Components
Windjammer (Charrette) Layout



Approximately 17% of WWTP Costs are "Variable" Based on Site



Sitework is Largest Variable Cost Component



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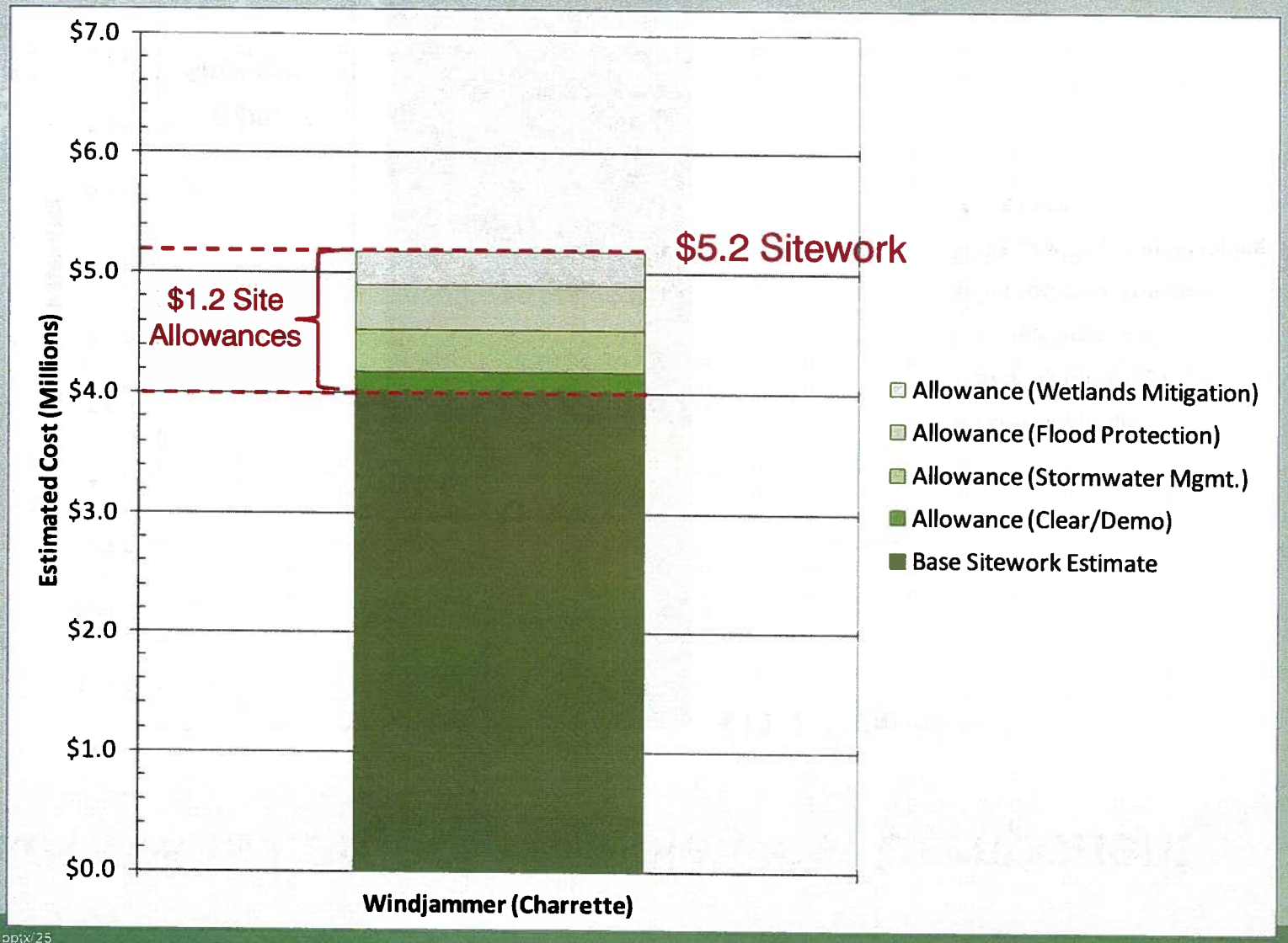
Sitework Cost Elements
Windjammer (Charrette) Layout



Property Adjacent to Windjammer Vicinity
Conceptual Plan View

Building Key

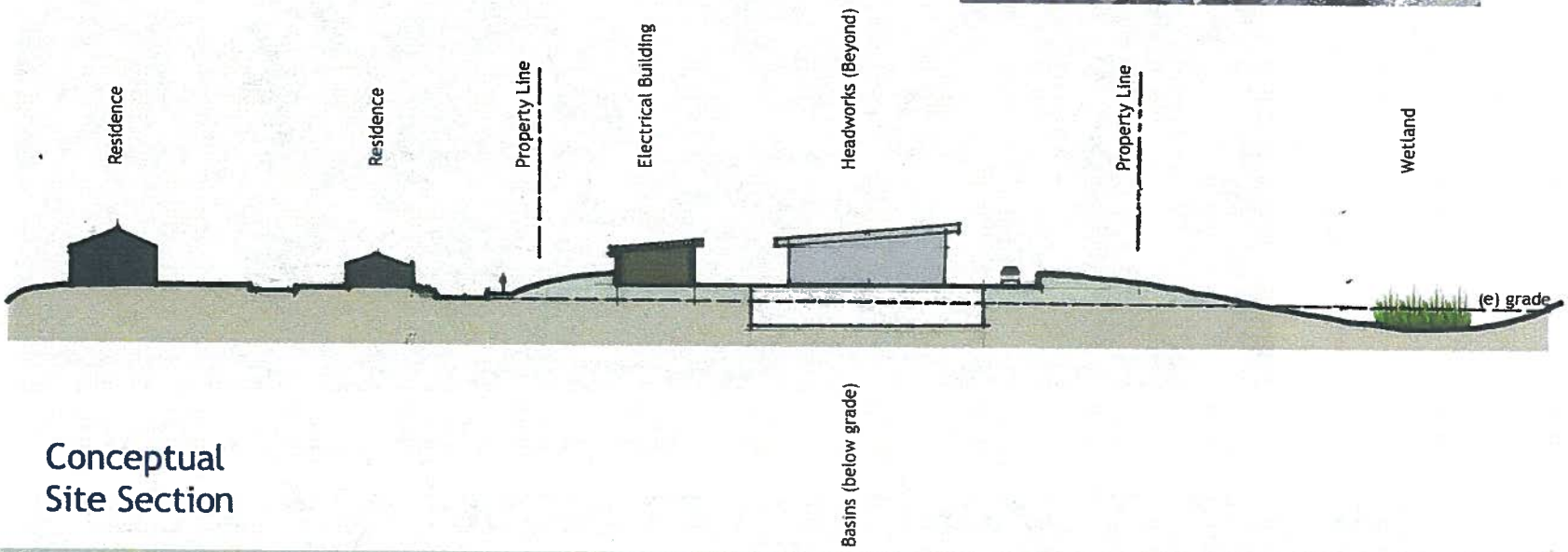
1. Administration Building
2. Maintenance Shop
3. Headworks
4. Aeration Basins (below grade)
5. Membrane Bioreactor (MBR) Building
6. Mechanical Building
7. Electrical Building
8. Chemical Building
9. Solids Building
10. Odor Control Building
11. UV Building

North

Conceptual Facility Layout

Property Adjacent to Windjammer Vicinity
Conceptual Site Section View

Key Plan



Conceptual
Site Section

Offsetting Costs for Alternate (Freund) Property
Relative to Windjammer (Charrette) Layout

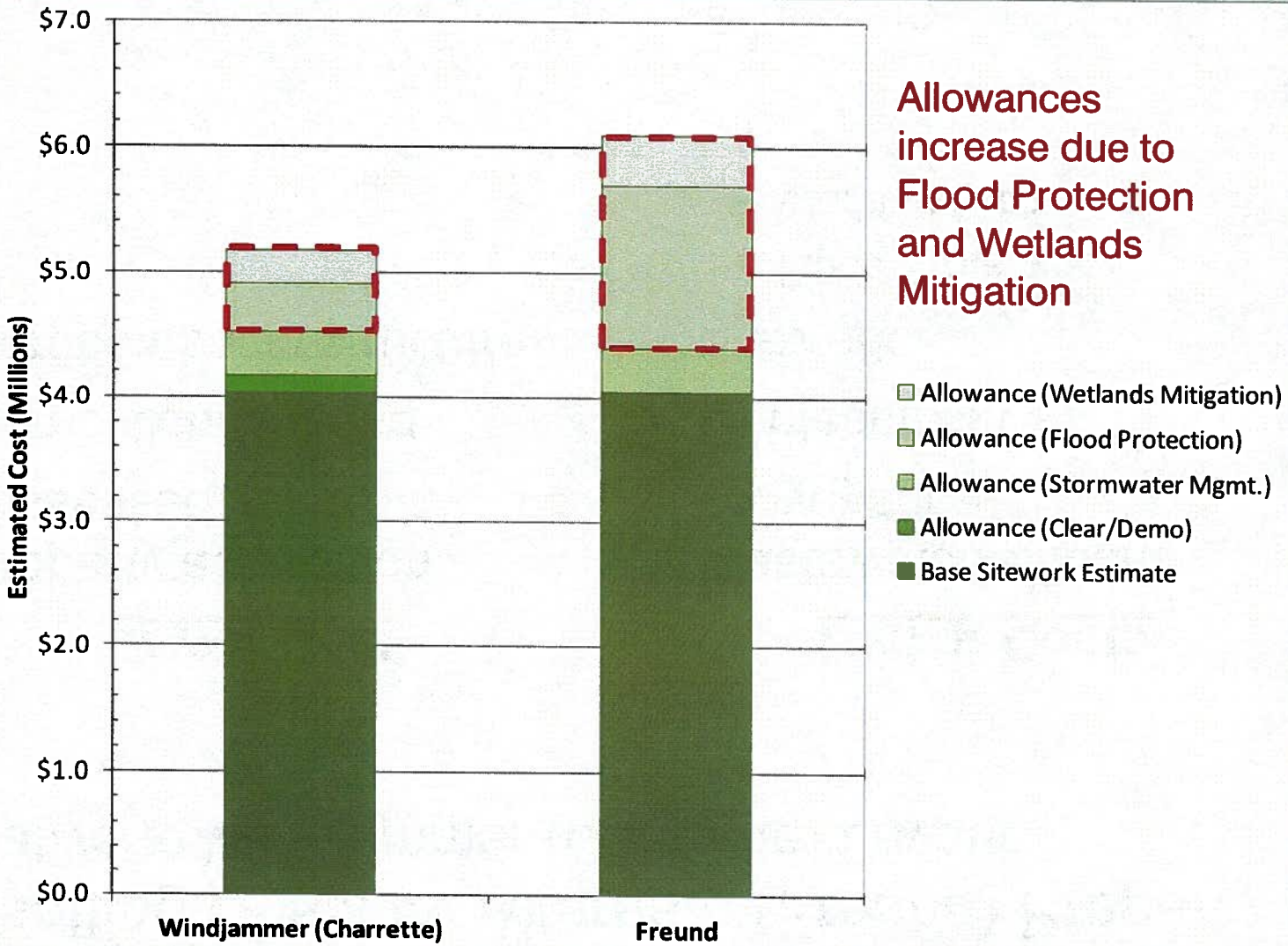
Lower Cost

- Property acquisition (Assessed value)
- Demolition/clearing
- Aeration basin structure

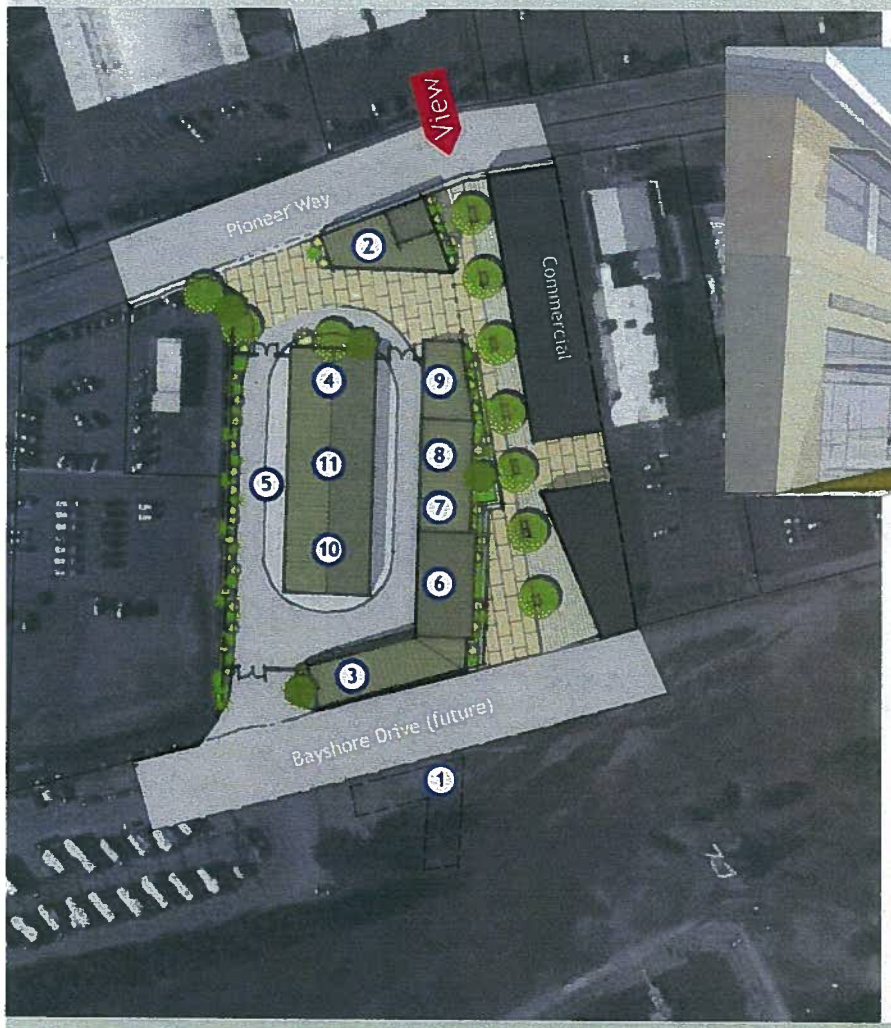
Higher Costs

- Wastewater/effluent conveyance
- Geotechnical
- Sitework
  - Flood Protection
  - Wetland Mitigation

Sitework Cost Element Comparison
Windjammer (Charrette) & Freund Layouts



Windjammer Alternate Concept
Conceptual Plan and Perspective View (8/14/12)



View From Pioneer Way Looking Toward Park

Building Key

1. Potential Community Building (cost not included)
2. Administration Building
3. Maintenance Shop
4. Headworks
5. Aeration Basins (buried beneath buildings)
6. Membrane Bioreactor (MBR) Building
7. Mechanical Building
8. Electrical Building
9. Chemical Building
10. Solids Building
11. Odor Control Building

North

Lower Costs for Windjammer (Alternate) Layout
Relative to Windjammer (Charrette) Layout

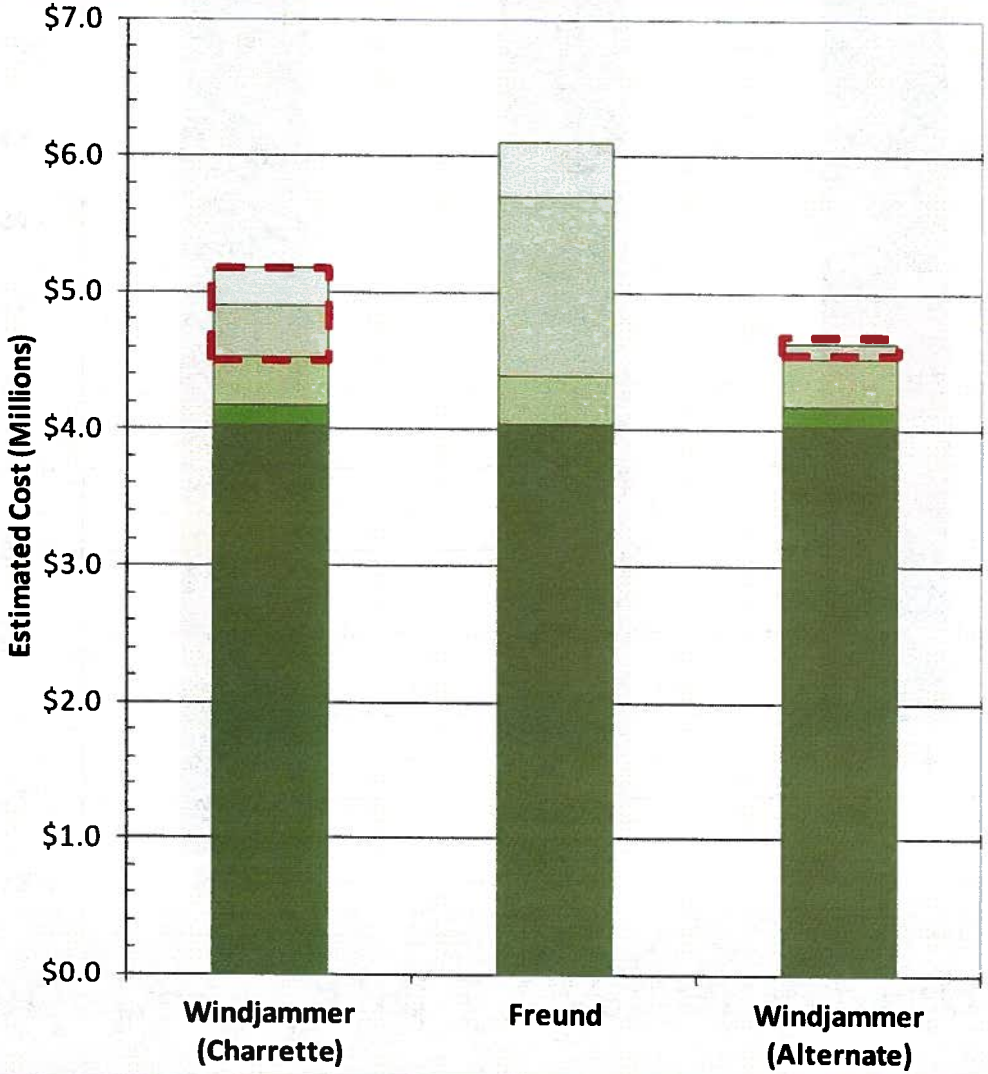
Same Cost

- Property acquisition (Assessed value)
- Demolition/clearing
- Wastewater/effluent conveyance

Lower Costs

- Aeration basin structure
- Geotechnical
- Sitework
  - Flood Control
  - Wetland Mitigation

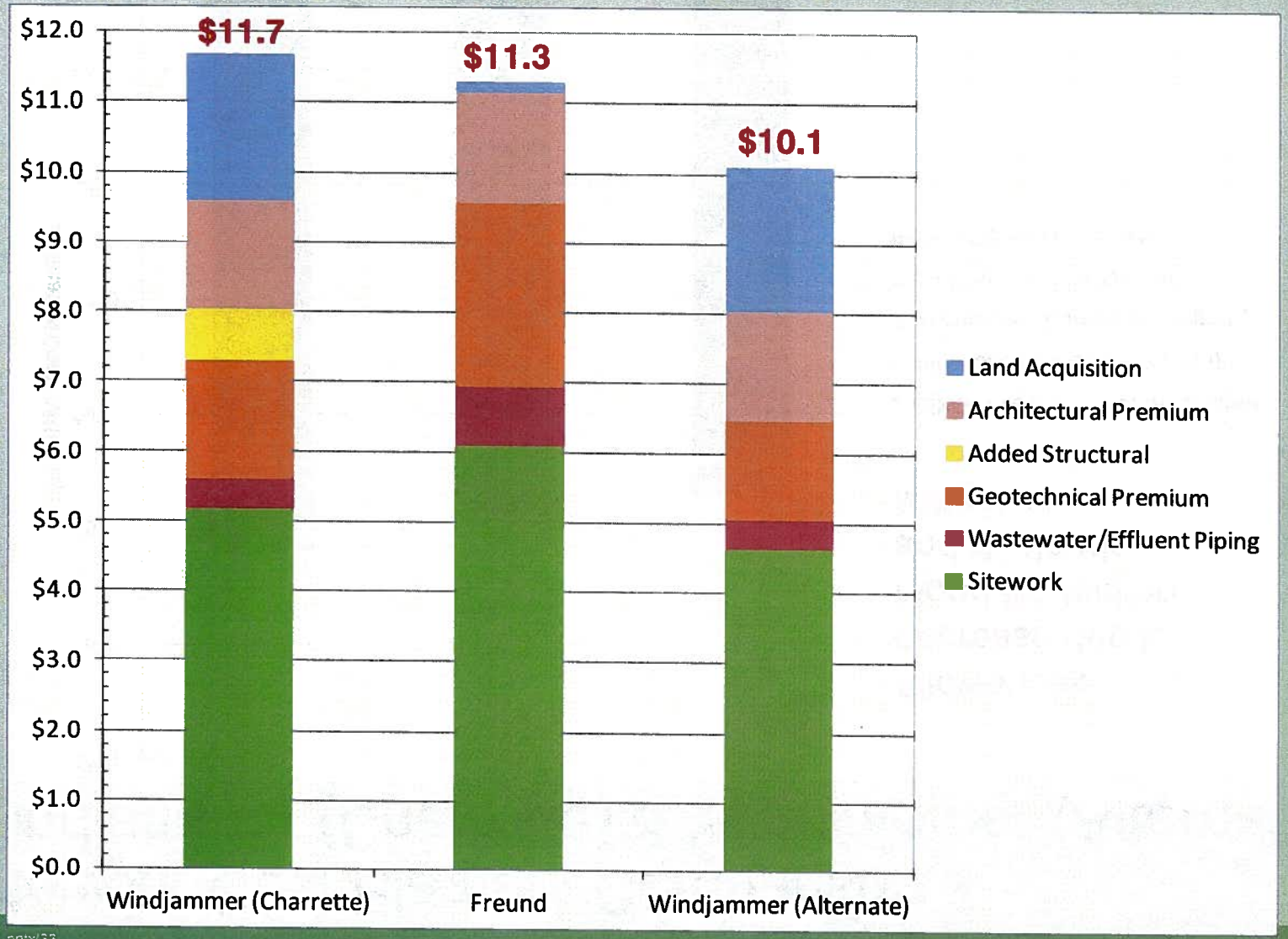
Sitework Cost Element Comparison
Windjammer (Charrette) & Windjammer (Alternate)



Allowances decrease due to Flood Protection and Wetlands Mitigation

- Allowance (Wetlands Mitigation)
- Allowance (Flood Protection)
- Allowance (Stormwater Mgmt.)
- Allowance (Clear/Demo)
- Base Sitework Estimate

"Variable" Cost Comparison for All Sites

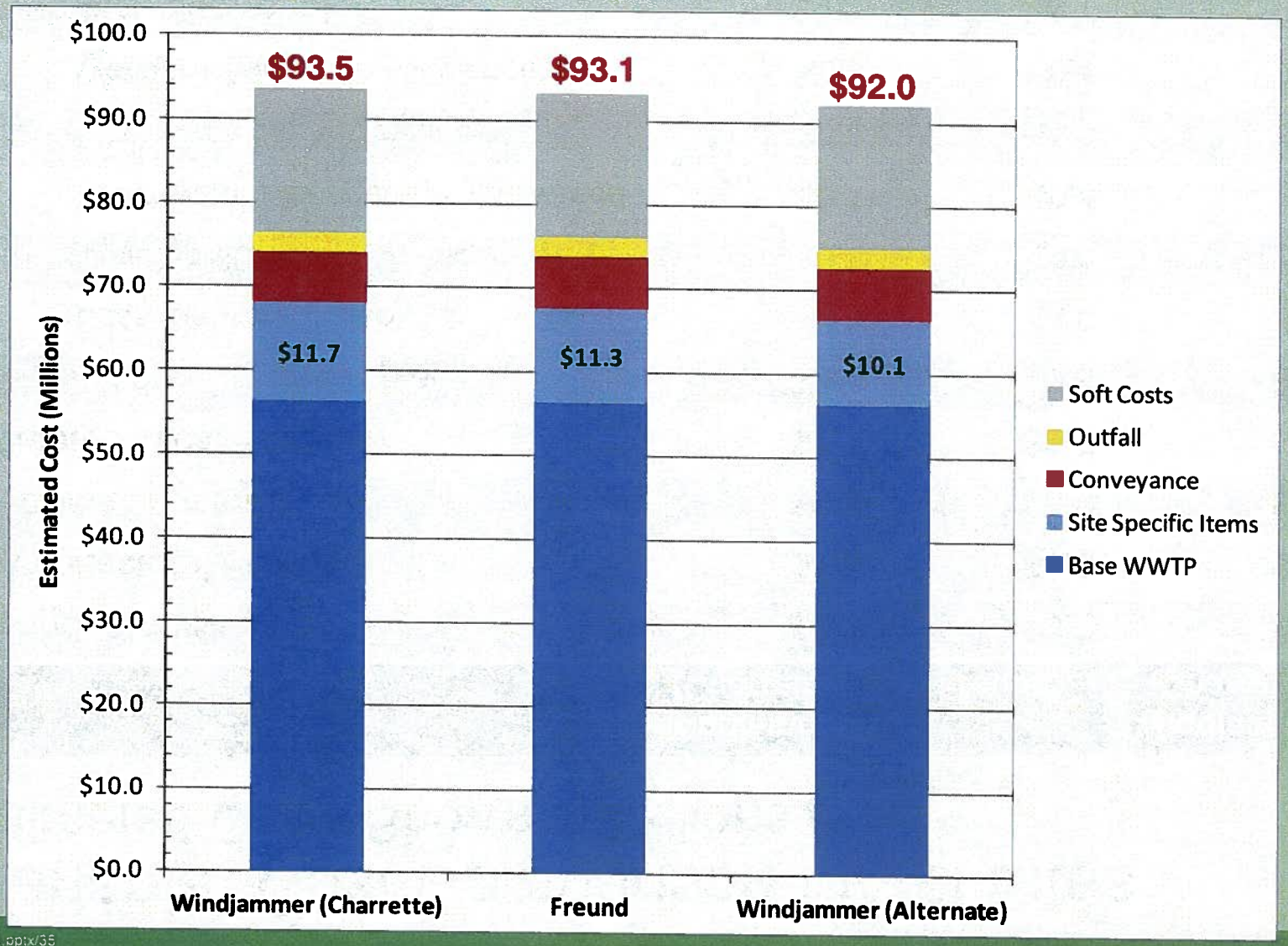


"Variable" Cost Comparison for All Sites

Estimated Costs Shown in Millions ($)

	Windjammer (Charrette)	Freund	Windjammer (Charrette)
Land Acquisition	$2.1	$0.2	$2.1
Architectural Premium	$1.6	$1.6	$1.6
Added Structural	$0.8	$0.0	$0.0
Geotechnical Premium	$1.7	$2.6	$1.4
Wastewater/Effluent Piping	$0.4	$0.8	$0.4
Base Sitework (Fixed)	$4.0	$4.0	$4.0
Clearing & Demolition Allowance	$0.2	$0.0	$0.2
Stormwater Management Allowance	$0.4	$0.4	$0.4
Flood Protection Allowance	$0.4	$1.3	$0.1
Wetlands Mitigation Allowance	$0.3	$0.4	$0.0
Subtotal, Sitework	$5.2	$6.1	$4.6
Total Site Specific Items	**$11.7**	**$11.3**	**$10.1**

Total Cost Comparison for All Sites

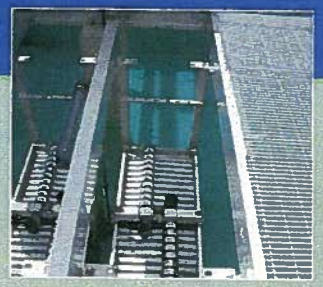


Summary of Technical & Cost Differences

Summary and Conclusions

1. Based on assessed value Freund site will likely be less costly to acquire
2. Based on technical field work, Freund site will likely have higher construction cost
   - Wastewater/effluent Conveyance
   - Geotechnical
   - Flood Protection
   - Wetland Mitigation
3. Very little difference in overall cost between sites
4. Means to reduce the cost of "variable" components will be considered regardless of tonight's decision
5. Freund site presents higher risk due to environmental permitting and regulations for filling within the flood plain

Next Steps



Paths Forward Based on Tonight's Decision

Retain Windjammer Vicinity

Resolution 12-33

1. Complete draft technical chapters of Facilities Plan
2. Develop phasing/financing plan
3. Final Public Open House/Council Workshop (Early 2013)
4. Council resolution to submit draft plan (Q1, 2013)
5. Complete environmental documents for approval
6. Begin Preliminary Design
   a. Final location & layout of WWTP with community input
   b. Equipment procurement

Expand Windjammer Vicinity (Freund)

Resolution 12-34

1. Amendment 6: Collect community input; compare locations using TBL+
2. Select final location/layout for WWTP with public input (Q1, 2013)
3. Complete draft technical chapters of Facilities Plan
4. Develop phasing/financing plan
5. Final Public Open House/Council Workshop (Q2, 2013)
6. Council resolution to submit draft plan (Q2, 2013)
7. Complete environmental documents for approval
8. Begin Preliminary Design
   a. Final layout of WWTP with community input
   Equipment procurement

Questions?

GEOENGINEERS

600 Dupont Street, Bellingham, Washington 98225, Telephone: 360.647.1510, Fax: 360.647.5044 www.geoengineers.com

Memorandum

To:	Brian Matson, PE and Anne Conklin, PE/Carollo Engineers
From:	J. Gordon, PE
Date:	November 13, 2012
File:	2751-017-01
Subject:	Preliminary Geotechnical Conclusions Oak Harbor WWTP Sites

INTRODUCTION

The purpose of this memorandum is to present preliminary geotechnical engineering findings and conclusions based on our exploration program that was completed October 30 and 31, 2012. Our services were performed in accordance with our task order with Carollo Engineers signed by Brian Matson on October 29, 2012. Our specific scope of services is included in the above referenced task order. The following is a summary of our scope of services completed to date:

- Reviewing geologic maps and available references in the project vicinity.
- Coordinating and completing the exploration plan discussed herein.
- Completing laboratory analysis on samples obtained during the explorations.
- Conducting preliminary geotechnical engineering analyses based on available information. This includes an assessment of liquefaction potential, foundation support considerations and estimation of relative costs.
- Preparing soil boring logs and cross sections.
- Preparing this memorandum summarizing the results of our explorations and analyses.

SURFACE CONDITIONS

We were asked to evaluate five different sites for comparison purposes. The locations of the sites and our explorations completed are shown in the attached Site Plan (Figure 1). Boring logs for each site are included as an attachment to this memorandum. For purposes of discussion in this document, these sites are described below:

- East Site (Boring 1) – located in a paved parking lot behind a bank administration building.
- Central Site (Borings 3 and 4) – located in a paved parking lot behind an automotive repair building.
- Park Site (Boring 12) – located in the City Beach Park, surface consists of manicured lawn.
- West Site (Borings 7 and 8) - located behind the Chrysler dealership in paved and gravel surfaced parking areas.
- Freund Site (Borings 9 and 10) - located in a plowed field west of South Beeksma Drive.

Based on our research and knowledge of the area, all five of these sites are located south of the original Oak Harbor shoreline. Historical photographs reviewed suggest the original bluff is close to the Pioneer Way alignment. GeoEngineers provided geotechnical engineering services for the recent Pioneer Way improvements and drilled an exploration in Pioneer Way right-of-way (ROW) slightly east of the intersection with SE City Beach Street. We observed approximately 5 feet of fill soils overlying native soil consisting of glacial till at that location. The historical aerial photographs suggest a historical saltwater slough (Freund Slough) meandered through and/or adjacent to all the sites.

GEOLOGIC CONDITIONS

We reviewed U.S. Geologic (USGS) map for the project area, "Geologic Map of the Oak Harbor, Crescent Harbor, and Part of the Smith Island 7.5-Minute Quadrangle, Island County, Washington" by Dragovich et. al. (2005). The geologic soil deposits are the result of both glacial and non-glacial processes that have occurred during the last 15,000 years. The most recent glacial event includes the Everson Insterstade and Vashon Stade of the Fraser Glaciation. Sea level fluctuated significantly relative to the land surface and present day sea level, in response to the glacial advance and retreat (melting). The various geologic units mapped and encountered at the sites are described below.

Artificial Fill: Artificial fill is mapped in the area of most of the sites. The fill can consist of dredged soils from Oak Harbor and other sources brought to the site over the last many decades. The fill was generally not compacted and/or placed below water and therefore is in a loose condition. This unit generally has low strength characteristics, will settle under loading conditions, and the sandier layers have a high liquefaction potential.

Beach Deposits: Beach deposits are mapped in the area although the extent is masked by the overlying fill that has been placed. These deposits are described as sand, gravel, pebbly sand and boulder gravel. These deposits are generally loose and in a saturated condition. Therefore these soils are considered liquefiable.

Saltwater Marsh Deposits: Marsh deposits are mapped more towards the bay. These deposits are described as organic rich silt and mud, commonly with layers of peat. These deposits possess very low shear strength and high compressibility characteristics.

Glaciomarine Drift: Glaciomarine drift is mapped north of the sites in the upland area but underlies some beach deposits at some of the sites. This unit is described as clay and clast-rich diamicton and mud. Glaciomarine drift is derived from sediment melted out of floating glacial ice that was deposited on the sea floor during periods of glacial retreat, while the land surface was depressed 500 to 600 feet from previous glaciations. This material locally contains shells and wood, and large erratics (boulders) can be present sporadically or even in a cluster. Sometimes the upper portion of this deposit is stiff and moderately compressible as a result of partial ice contact loading; however, it oftentimes grades or occurs as medium stiff or soft. This material has moderate shear strength and compressibility when stiff; it has low shear strength and high compressibility when soft.

Glacial Till: Glacial till is located north of the sites in the upland areas but underlies the other soil units at all the sites. The till is described as an unsorted mixture of silt, sand and gravel that was deposited under the glaciers. The till can also contain large erratics (very large boulders) which occur sporadically. The till was deposited and overridden by the glaciers. Because this unit has been glacially consolidated by several thousand feet of ice, it is in a very dense condition with high shear strength and low compressibility characteristics.

SUBSURFACE CONDITIONS

We completed eight borings to depths of 30½ to 53 feet below the ground surface (bgs) on October 30 and 31, 2012. The draft boring logs are attached to this memorandum. The elevations provided on the borings were provided by the project surveyor. The borings were completed with a track-mounted drill rig subcontracted to GeoEngineers. All boring locations were coordinated with City personnel and with the project archeologist. Cuttings were left on-site to be investigated by the project archeologist and removed by City of Oak Harbor personnel. Based on our conversations with the archeologist, we understand that no evidence of shell midden was observed in the cuttings at any of the sites.

The borings were backfilled with bentonite chips in accordance with Department of Ecology requirements, and an asphalt patch placed at the top where the borings were completed in paved areas. Twelve boring locations were identified and are shown on the Site Plan; eight were completed due to drilling depth and time required to reach the bearing layer. A generalized description of the stratigraphy is provided below.

Fill Soils

- Fill was encountered in all borings at all of the sites, extending from ground surface down to 10 to 15 feet bgs.
- Some of the fill appears to be dredge spoils, a relatively clean sand with little gravel, or a silty sand with gravel:
  - The density is loose to medium dense;
  - The fill material generally has a low bearing capacity, and high liquefaction potential when below the water table.
- Silt layers were encountered near 5 feet bgs in B-3, B-4, B-7 and B-8.

Beach Deposits

- Beach deposits were encountered in all the borings and extended to the following approximate depths bgs at the respective borings:
  - 38 feet on the East site;
  - 30 feet on the Central site;
  - 34 feet on the Park site;
  - 24 to 25 feet on the West site; and
  - 34 to 39 feet on the Freund site.
- The beach deposits typically consist of sand with variable silt and gravel content, some shells:
  - A layer of fine-grained silt was encountered on the Freund site;
  - The density is loose to medium dense; and
  - The fill material generally has a low bearing capacity and high liquefaction potential.

Glaciomarine Drift

- Clayey silt/silty clay was encountered at two sites:
  - At the East site in B-1 and extended from approximately 38 to 50 feet bgs:
    - The glaciomarine drift was very soft at this site.
    - This unit has low shear strength, is very compressible under new loading and is generally not considered liquefiable.
  - At the Freund site and extended from approximately 34 to 40 feet bgs in B-9, and 40 to 52½ feet bgs in B-10:
    - The glaciomarine drift was stiff grading to medium stiff at this site.
    - This unit has low to moderate shear strength, is moderately compressible under new loading and has a low liquefaction potential.

Glacial Till

- Gray silty sand with gravel was encountered in all borings at all sites at the following approximate depths bgs:
  - 50 feet on the East site;
  - 30 feet on the Central site;
  - 34 feet on the Park site;
  - 29 to 30 feet on the West site; and
  - 40 to 51 feet on the Freund site.
- This is a glacially consolidated layer:
  - The density was very dense and it was difficult to drill; and
  - This unit has very high shear strength, high bearing capacity, is generally not considered compressible under normal loading, and is not considered liquefiable.

Groundwater Conditions

A high groundwater table was encountered in all of our borings. We have provided a summary of the groundwater depths and elevations encountered at the time of drilling in the table below.

Boring	Site Location	Depth to Groundwater (bgs)	Approximate groundwater elevation
B-1	East Site	5 ft	6.2 ft
B-3	Central	6.5 ft	5.9 ft
B-4	Central	4.5 ft	6.6 ft
B-7	West Site	4.5 ft	6.3 ft
B-8	West Site	4.5 ft	6.4 ft
B-9	Freund Site	3 ft	6.2 ft
B-10	Freund Site	2.3 ft	6.6 ft
B-12	Park Site	3.5 ft	5.1 ft

We did not install any monitoring wells nor were the explorations left open long enough for the groundwater level to stabilize. We expect groundwater conditions to vary based on a variety of factors such as precipitation, tides, seasons and other factors.

GEOTECHNICAL CONSIDERATIONS

All of the sites are located in a lowland area that has historically been filled over an intertidal area with a high groundwater table. We observed a significant depth of fill soils that are liquefiable when below groundwater, and sandy beach deposits that are liquefiable. Two of the sites (East and Freund) are underlain by a moderate to highly compressible layer of clay. While not unusual to find these types of soils within shoreline environments where wastewater treatment facilities are located, it is important to consider the impacts for such critical facilities. The following is a summary of various geotechnical considerations for each of the sites.

Liquefaction

All of the sites are underlain by soil stratigraphy that is subject to liquefaction during a design earthquake. Liquefaction occurs in loose saturated (below the water table) sandy soils such as the fill and beach deposits encountered at all the sites as previously described. Earthquake shaking results in a loss of shear strength and settlement. The magnitude of the settlement is determined largely by the thickness and density of the soil profile. The following table identifies the estimated range of vertical settlement based on the design earthquake that has a 2 percent probability of exceedance in 50 years (Return period of 2575 years), which is a typical design consideration.

Site Location	Estimated Liquefaction induced vertical settlement
East Site	11 to 15 inches
Central Site	8 to 10 inches
Park Site	8 to 10 inches
West Site	4 to 6 inches
Freund Site	11 to 15 inches

Liquefaction Mitigation Strategies

The effects of liquefaction can be mitigated by various methods and/or combinations of methods such as:

Ground Improvement by Stone Columns. This ground improvement method increases the density of the soil profile by installing a pattern of dense vertical columns of stone with a crane-mounted probe. The probe is jetted down through the liquefiable soil profile to the bearing layer (in this case either the glaciomarine drift or the glacial till); then rock is dispersed from the bottom of the probe and densified by vibration. The vibration from the installation method also densifies surrounding granular soil deposits, and is ideally suited for the granular fill and beach deposits encountered at these sites. The pattern of stone columns creates a composite material of lower overall compressibility and higher shear strength than the native soil alone. This method can be used under structures and other facilities to a) mitigate settlement from liquefaction and b) increase the bearing capacity of the soils so that conventional shallow foundation construction and/or mat foundations can be utilized. It is our experience that this mitigation measure a) is more cost effective than traditional pile foundations and b) results in better overall site performance during seismic events.

- Areas and structures with ground improvement will not settle significantly during an earthquake. However, all other infrastructure supported in non-improved areas would settle (see liquefaction settlement estimates above). This puts significant stress on transitions for piping and utility connections.
  - It may be appropriate to consider ground improvement in "utility corridors" to provide mitigation for these critical structures, or incorporate flexible connections or other mitigation measures.
- Since no soil is removed, the rock columns result in added weight to the soil profile. Most of the lightly loaded structures (e.g., administrative and maintenance storage buildings) will not add significant weight to the soil profile; however, the larger structures such as the aeration basin may also apply additional loading that must be considered when a site is underlain by compressible soils.
  - Glacial till underlies the liquefiable soils at the Central, Park and West sites. The glacial till will serve as the bearing layer and is not considered compressible under these new loads.
  - The East site has 12 feet of highly compressible glaciomarine drift and the Freund site has 6 to 12 feet of moderately compressible glaciomarine drift. We don't have sufficient design and soil consolidation information at this time to estimate post construction (after stone column and buildings) construction. We estimate that the range of settlement at the East site might be in the range of 3 to 6 inches and the range of settlement at the Freund site might be 2 to 4 inches. The settlement would occur over many years (estimated to be 10 to 20 years) and would occur as a general ground warping rather than sharp differential settlement. Therefore, this consideration is appropriate for flood levels, but not necessarily design of the structures.

Pile Foundations. Structures could be supported on piles bearing on the underlying glacial till. Driven steel piles or augercast piles can be used in this environment, although the pile foundation has some disadvantages.

- The main consideration for this alternative is that the ground surface below and around the piles will settle from liquefaction because ground improvement is generally not performed when piles are used as the mitigation strategy.
- Pile supported structures will not settle during an earthquake. However, all other non-pile supported infrastructure would settle (see liquefaction settlement estimates above). This puts significant stress on transitions for piping and utility connections. The post-earthquake result would be voids underneath the pile supported structures.
- At both the East site and the Freund site, pile capacity reductions would occur because downdrag forces will be applied to the piles as the soil profile settles.
- For the reasons identified above, pile foundations were not considered a preferred mitigation option.

Mat foundations. A mat foundation may be suitable for lightly loaded structures (see discussion below). Ground improvement may not be necessary if the settlement can be tolerated.

Shallow Foundation Considerations

It is our opinion that conventional shallow foundation construction absent ground improvement or pile support is not appropriate at any of these sites. Typical convention is to assume differential settlement one-half or equal to the total predicted liquefaction settlement. Structures cannot accommodate the magnitude of settlement predicted. Options are discussed below.

- Mat or raft foundations could be used on some structures. This is a continuous reinforced concrete foundation that will allow the entire structure to perform similarly. We expect that the heavily loaded structures such as aeration basin will have continuous bases that essentially serve as mat foundations. Where ground improvement is completed in advance, the mat foundations will perform very well.
- It may be possible to use a mat foundation without ground improvement for lightly loaded structures at some of the sites, particularly the West site which has a lower magnitude of settlement predicted. Again, transitions would need to be considered such as utilities.
- Conventional shallow foundation design (spread footings and slab-on-grade) can be used after ground improvement for lightly loaded structures such as administration and equipment storage.

Construction Dewatering

All sites with excavations greater than about 5 to 10 feet below existing grades will require construction dewatering and/or shoring for installation and construction of subsurface elements. For deeper excavations such as the aeration basin, we anticipate that sheet piles will be required. Sheet piles installed to glacial till or glaciomarine drift will essentially cut off the water source after internal dewatering.

All of the groundwater elevations observed were within 2 feet of elevation from each other. Therefore, the advantage lies with sites where a dense impermeable layer was encountered at a higher elevation; such as the Central, Park and West sites. This will allow for shorter sheet pile and shoring installations as well as shorter dewatering elements.

Flood Considerations

The sites are all located near the shoreline for Oak Harbor. Some portions of the sites are located within a flood inundation zone. Some or all of sites will require flood protection berms to prevent inundation during a flood event. Liquefaction, lateral spreading of embankments, loss of bearing capacity for levees must be considered for site development as well. These considerations will need to be evaluated in detail once a site is chosen and designs considered. For purposes of site selection, the following information is provided:

- The northern sites (East, Central and West) are mostly at or above the flood elevation. It appears that the stability of the southern edge of these sites would need to be evaluated. If ground improvement is used, the structures may be secure above the flood elevation after an earthquake.
- The Park site and the Freund site are at lower elevations such that either these sites must be raised, flood berms installed, or a hybrid system used. It is likely that ground improvement will be required

for support of some of the embankment and/or the flood control levees placed for construction of these sites.

SUMMARY AND CONCLUSIONS

All of the sites investigated are subject to liquefaction and dewatering related issues. Impacts associated with raising site grades for flood control, depth to non-liquefiable soils, and presence of soft soils that will settle will also influence cost. For comparative analysis, our preliminary conclusion is that the preferred option to mitigate liquefaction and settlement will be installation of stone columns.

For purposes of discussion at this level of assessment, it was considered necessary to install ground improvement the full depth of the liquefiable soils, which varies by site from approximately 30 to 40 feet. Based on our experience, stone column spacing on the order of 7- to 10-feet is typical within a structure footprint, providing about 25 percent to 15 percent (respective) replacement ratio for 42-inch diameter stone columns. A closer spacing is used under perimeter spread footings and isolated columns to typical buildings. Typically, the area in which stone columns are installed extend at least 10- to 20-feet (one to two rows) laterally beyond the edges of structures. Tighter spacings will be used for heavily loaded structures with raft foundations such as the aeration basin on this project.

As a basis for comparative site analysis we obtained stone column installation cost data from Hayward Baker, a ground improvement specialty contractor in Seattle, Washington. For an average ground improvement depth of 30 feet, the estimated cost of the ground improvement is on the order of $18/square foot (SF) to $30/SF of structure footprint. The lower unit cost is appropriate for lightly loaded structures with a maximum design floor load of 250 pounds per square foot (psf) (e.g. non-process buildings or non-water bearing structures); the higher cost would be for a more heavily loaded two-story structure with a design floor load of 500 psf and/or for water bearing structures. Ground improvement costs also vary as a function of depth. For the purpose of this analysis, it can be assumed that unit costs for installing stone columns between 10 and 40 feet deep will vary in a linear fashion relative to the depth of the installation.

Based on site conditions and development considerations as discussed above, we are able to make the following conclusions related to geotechnical conditions and associated cost of site development:

1. **West and Central Sites.** These sites are similar from a geotechnical standpoint. The West site has the shallowest depth to glacial till at 29 to 30 feet and no soft compressible soils. The Central site has glacial till at 30 feet and no soft compressible soils. Relative to other sites, ground improvements to mitigate liquefaction and settlement will be the least costly. Both sites will require some additional fill, but not much considering present grades.

2. **Park Site.** This site has glacial till at 34 feet and no soft compressible soils based on the one boring. Ground improvements will be more costly on this site, due to increased depth to non-liquefiable soils. The site will also require more fill than the sites to the north because it is at a lower elevation.

3. **East and Freund Sites.** The East site has very soft glaciomarine drift at 38 feet and glacial till at 50 feet in the one boring. The glaciomarine drift is highly compressible, which likely may require some additional mitigation. The Freund site has glaciomarine drift at 34 and 40 feet and glacial till at 40 and 52½ feet in the two borings. The glaciomarine drift is moderately compressible, which may

not require additional mitigation. Relative to other sites, ground improvements to mitigate liquefaction and settlement will be the most costly. Both sites will also require additional fill to mitigate flood risk. The Freund site is the lowest and will require significantly more fill, berms or other flood protection measures. It is likely that at least some limited ground improvement of the flood control measures will be necessary to stabilize this site.

Attachments:
Figure 1. Site Plan
Figure 2. Key to Boring Logs
Figures 3 through 10. Logs of Borings (DRAFT)
Figures 11 and 12. Cross Sections (DRAFT)

Map Revised: 08 November 2012 bmagdasy

Path: W:\Bellingham\Projects\2\2751017\GIS\002751017_F2_SitePlan.mxd

Office: BEL

Legend

Boring location

A' Cross Section

N W E S

400 0 400

Feet

Projection: WGS 1984 Web Mercator Auxiliary Sphere

Notes:

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Site Plan

City of Oak Harbor
Windjammer Site Evaluation
Oak Harbor, Washington

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Figure 1

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS MORE THAN 50% RETAINED ON NO. 200 SIEVE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS
				SP	POORLY-GRADED SANDS, GRAVELLY SAND
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% PASSING NO. 200 SIEVE	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS, ROCK FLOUR, CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS AND SILTS OF MEDIUM TO HIGH PLASTICITY
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: Multiple symbols are used to indicate borderline or dual soil classifications

ADDITIONAL MATERIAL SYMBOLS

SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
	AC	Asphalt Concrete
	CC	Cement Concrete
	CR	Crushed Rock/ Quarry Spalls
	TS	Topsoil/ Forest Duff/Sod

Groundwater Contact

- Measured groundwater level in exploration, well, or piezometer
- Groundwater observed at time of exploration
- Perched water observed at time of exploration
- Measured free product in well or piezometer

Graphic Log Contact

- Distinct contact between soil strata or geologic units
- Approximate location of soil strata change within a geologic soil unit

Material Description Contact

- Distinct contact between soil strata or geologic units
- Approximate location of soil strata change within a geologic soil unit

Sampler Symbol Descriptions

- 2.4-Inch I.D. split barrel
- Standard Penetration Test (SPT)
- Shelby tube
- Piston
- Direct-Push
- Bulk or grab

Blowcount is recorded for driven samplers as the number of blows required to advance sampler 12 inches (or distance noted). See exploration log for hammer weight and drop.

A "P" indicates sampler pushed using the weight of the drill rig.

Laboratory / Field Tests

%F	Percent fines
AL	Atterberg limits
CA	Chemical analysis
CP	Laboratory compaction test
CS	Consolidation test
DS	Direct shear
HA	Hydrometer analysis
MC	Moisture content
MD	Moisture content and dry density
OC	Organic content
PM	Permeability or hydraulic conductivity
PP	Pocket penetrometer
PPM	Parts per million
SA	Sieve analysis
TX	Triaxial compression
UC	Unconfined compression
VS	Vane shear

Sheen Classification

NS	No Visible Sheen
SS	Slight Sheen
MS	Moderate Sheen
HS	Heavy Sheen
NT	Not Tested

NOTE: The reader must refer to the discussion in the report text and the logs of explorations for a proper understanding of subsurface conditions. Descriptions on the logs apply only at the specific exploration locations and at the time the explorations were made; they are not warranted to be representative of subsurface conditions at other locations or times.

KEY TO EXPLORATION LOGS

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FIGURE 2

Start Drilled	End	Total Depth (ft)	Logged By / Checked By	Driller	Drilling Method
10/30/2012	10/30/2012	51.5	AJH	Boretec	Hollow-Stem Auger

Surface Elevation (ft) / Vertical Datum	11.23 / NAD 83	Hammer Data	Rope & Cathead / 140 (lbs) / 30 (in) Drop
Drilling Equipment	M55 Track-mounted		
Easting (X) / Northing (Y)	1197538.46 / 474654.45	System Datum	
Notes:			

Groundwater	Depth to Water (ft)	Elevation (ft)
Date Measured		
10/30/2012	5.0	6.23

Depth (feet)	Interval Recovered (in)	Blows/foot	Collected Sample / Sample Name Testing	Water Level	Group Classification	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, (pcf)	REMARKS
0					AC	1½ inches of asphalt concrete			
					SP-SM	Brown fine to coarse sand with silt and gravel (medium dense, moist) (fill)			
	8	13	1				14		
5	18	12	2	▽	SP-SM	Gray fine to coarse sand with silt and gravel (medium dense, wet)	17		
	18	6	3 %F			Becomes loose with trace shells	17		%F = 6
10	18	11	4		SP	Gray fine to coarse sand with shells (loose to medium dense, wet) (beach deposits)	10		
	18	14	5				13		
15	12	8	6				11		
	12	21	7 %F		SP-SM	Gray fine to coarse sand with silt and gravel (medium dense, wet)	16		%F = 9
20	6	19	8			With trace shells	13		
	12	13	9 %F		SP	Gray fine to coarse sand with gravel, organic matter, and trace silt and shells (medium dense, wet)	13		%F = 3
25									

Note: See Figure 2 for explanation of symbols.

Log of Boring B-1

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Project: Oak Harbor Wastewater Treatment Plant
Project Location: Oak Harbor, Washington
Project Number: 2751-017-01

Figure 3
Sheet 1 of 2

Elevation (feet)	Depth (feet)	FIELD DATA: Interval Recovered (in)	Blows/foot	Collected Sample	Sample Name / Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, (pcf)	REMARKS
	25	12	25		10					12		
15								SM	Gray silty fine to coarse sand with occasional organic matter (loose, wet)			
	30	12	8		11					23		
20								SP	Gray fine to medium sand with trace shells and silty zones (medium dense, wet)			
	35	12	23		12					22		
25								CL	Gray silty clay (very soft to soft, wet) (glaciomarine drift)			
	40	18	2		13					41		
30												
	45	18	2		14a 14b					41		
35												
	50	18	73		15					15		
40								SM	Gray silty fine to coarse sand with gravel (dense, wet) (till)			

Note: See Figure 2 for explanation of symbols.

Log of Boring B-1 (continued)

GEOENGINEERS

Project: Oak Harbor Wastewater Treatment Plant
Project Location: Oak Harbor, Washington
Project Number: 2751-017-01

Figure 3
Sheet 2 of 2

Start Drilled 10/30/2012	End 10/30/2012	Total Depth (ft) 36	Logged By AJH Checked By	Driller Boretec	Drilling Method Hollow-Stem Auger
Surface Elevation (ft) 12.46 Vertical Datum NAD 83			Hammer Data Rope & Cathead 140 (lbs) / 30 (in) Drop	Drilling Equipment M55 Track-mounted	
Easting (X) 1197046.02 Northing (Y) 474597.08			System Datum	Groundwater Date Measured 10/30/2012	Depth to Water (ft) 6.5 / Elevation (ft) 5.96
Notes:					

Depth (feet)	Interval Recovered (in)	Blows/foot	Collected Sample / Sample Name / Testing	Water Level	Group Classification	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, (pcf)	REMARKS
0					AC	2 inches of asphalt concrete			
					SP-SM	Gray-brown fine to coarse sand with silt and gravel (medium dense, moist) (fill)			
	8	13	1				7		
5	18	4	2		ML	Gray silt with sand and organic matter (soft, moist)	29		
				▽		Becomes wet			
	18	2	3				32		
						With occasional rootlets			
10	18	5	4 %F		SP-SM	Gray fine to coarse sand with silt and occasional gravel (loose, wet)	18		%F = 6
	12	7	5 %F		SP	Gray fine to coarse sand with gravel and trace silt (loose, wet)	14		%F = 4
15	12	10	6 %F		SP-SM	Gray fine to coarse sand with silt and gravel (loose to medium dense, wet) (beach deposits)	17		%F = 6
20	12	6	7 %F				13		%F = 8
						Becomes loose with occasional shells			
					SP-SM	Gray fine to coarse sand with silt, gravel, and shells (loose, wet)			
25									

Note: See Figure 2 for explanation of symbols.

Log of Boring B-3

GEOENGINEERS

Project: Oak Harbor Wastewater Treatment Plant
Project Location: Oak Harbor, Washington
Project Number: 2751-017-01

Figure 4
Sheet 1 of 2

Elevation (feet)	Depth (feet)	FIELD DATA: Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, (pcf)	REMARKS
	25		18	6		8					18		
-15													
	30		14	72		9					7		
									SM	Gray silty fine to coarse sand with gravel (very dense, wet) (till)			
-20													
	35		12	56		10					14		

Note: See Figure 2 for explanation of symbols.

Log of Boring B-3 (continued)

GEOENGINEERS

Project: Oak Harbor Wastewater Treatment Plant
Project Location: Oak Harbor, Washington
Project Number: 2751-017-01

Figure 4
Sheet 2 of 2

Drilled Start 10/30/2012	End 10/30/2012	Total Depth (ft) 35.5	Logged By AJH / Checked By	Driller Boretec	Drilling Method Hollow-Stem Auger
Surface Elevation (ft) 11.12 / Vertical Datum NAD 83			Hammer Data Rope & Cathead 140 (lbs) / 30 (in) Drop		Drilling Equipment M55 Track-mounted
Easting (X) 1197053.67 / Northing (Y) 474524.73			System Datum		Groundwater: Date Measured 10/30/2012; Depth to Water (ft) 4.5; Elevation (ft) 6.62
Notes:					

Elevation (feet)	Depth (feet)	Interval Recovered (in)	Blows/foot	Collected Sample	Sample Name Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, (pcf)	REMARKS
	0							AC	1½ inches of asphalt concrete			
								SM	Brown silty fine to coarse sand with gravel (loose, moist) (fill)			
		6	2		1					15		
						▽						Clay in sampler shoe
								ML	Brown silt with rootlets (soft, wet)			
	5	18	3		2a					56.5		
					2b			SP	Gray medium to coarse sand with trace silt (loose, wet)	19		
		18	7		3 %F					20		%F = 4
								SP-SM	Gray fine to coarse sand with silt and occasional organic matter (loose, wet)			
	10	6	3		4 %F					30		%F = 6
								SP-SM	Gray fine to coarse sand with silt and occasional shells (loose, wet) (beach deposits)			
		8	7		5 %F					14		%F = 5
	15		8		6			SM	Gray silty fine to medium sand with trace shells (loose, wet)	19		
	20	18	7		7					21		
	25											

Note: See Figure 2 for explanation of symbols.

Log of Boring B-4

GEOENGINEERS

Project: Oak Harbor Wastewater Treatment Plant
Project Location: Oak Harbor, Washington
Project Number: 2751-017-01

Figure 5
Sheet 1 of 2

Elevation (feet)	Depth (feet)	FIELD DATA: Interval Recovered (in)	Blows/foot	Collected Sample	Sample Name Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, (pcf)	REMARKS
	25	8	18		8				With occasional organic matter, becomes medium dense	26		
15								SM	Gray silty fine to coarse sand with gravel (very dense, wet) (till)			
	30	6	50/3"		9					14		
20												
	35	2	50/6"		10					12		

Note: See Figure 2 for explanation of symbols.

Log of Boring B-4 (continued)

GEOENGINEERS

Project: Oak Harbor Wastewater Treatment Plant
Project Location: Oak Harbor, Washington
Project Number: 2751-017-01

Figure 5
Sheet 2 of 2

Start	End	Total Depth (ft)	Logged By	Driller	Drilling Method
Drilled 10/31/2012	10/31/2012	35.5	AJH Checked By	Boretec	Hollow-Stem Auger

Surface Elevation (ft) Vertical Datum	10.86 NAD 83	Hammer Data	Rope & Cathead 140 (lbs) / 30 (in) Drop	Drilling Equipment	M55 Track-mounted
Easting (X) Northing (Y)	1196733.56 474477.83	System Datum		Groundwater	
Notes:				Date Measured: 10/30/2012	Depth to Water (ft): 4.5 / Elevation (ft): 6.36

Elevation (feet)	Depth (feet)	Interval Recovered (in)	Blows/foot	Collected Sample	Sample Name / Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, (pcf)	REMARKS
	0	6	8		1			SM	Brown silty fine to coarse sand with gravel (loose, moist) (fill)	13		
	5	18	9		2			ML	Gray sandy silt with occasional organic matter (stiff, wet)	47		
		6	8		3			SM	Gray silty fine to medium sand with occasional organic matter (loose, wet)	14		
								SM	Gray silty fine to coarse sand with gravel and trace shells (loose, wet)			
	10	12	7		4 %F			SP	Gray fine to coarse sand with gravel, trace shells and silt (loose, wet)	16		%F = 3.1
		8	12		5				Becomes medium dense	16		
	15	12	15		6 %F			SP	Gray fine to medium sand with trace silt (medium dense, wet) (beach deposits)	3		%F = 3.0
		18	21		7			SP-SM	Gray fine sand with silt and trace shells (medium dense, wet)	22		
	20	14	14		8					23		
		18	13		9 %F			SP-SM	Gray fine to coarse sand with silt, gravel, and shells (medium dense, wet)	15		%F = 8.7
	25											

Note: See Figure 2 for explanation of symbols.

Log of Boring B-7

GeoEngineers

Project: Oak Harbor Wastewater Treatment Plant
Project Location: Oak Harbor, Washington
Project Number: 2751-017-01

Figure 6
Sheet 1 of 2

Elevation (feet)	Depth (feet)	FIELD DATA: Interval Recovered (in)	Blows/foot	Collected Sample	Sample Name Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, (pcf)	REMARKS
	25	6	17		10			SM	Gray silty fine to coarse sand with gravel (medium dense, wet) (transition zone)	13		
-15								SM	Gray silty fine to coarse sand with gravel (very dense, wet) (till)			
	30	17	50/5"		11					15		
-20												
	35	3	50/6"		12					11		

Note: See Figure 2 for explanation of symbols.

Log of Boring B-7 (continued)

GEOENGINEERS

Project: Oak Harbor Wastewater Treatment Plant
Project Location: Oak Harbor, Washington
Project Number: 2751-017-01

Figure 6
Sheet 2 of 2

Start Drilled 10/31/2012	End 10/31/2012	Total Depth (ft) 30.5	Logged By AJH Checked By	Driller Boretec	Drilling Method Hollow-Stem Auger
Surface Elevation (ft) 10.91 Vertical Datum NAD 83			Hammer Data Rope & Cathead 140 (lbs) / 30 (in) Drop	Drilling Equipment M55 Track-mounted	
Easting (X) 1196609.98 Northing (Y) 474430.86			System Datum	Groundwater Date Measured 10/30/2012	Depth to Water (ft) 4.5 / Elevation (ft) 6.41
Notes:					

Depth (feet)	Interval Recovered (in)	Blows/foot	Sample Name Testing	Group Classification	MATERIAL DESCRIPTION	Moisture Content, %	REMARKS
0	3	21	1	SM	Brown silty fine to coarse sand with gravel (medium dense, moist to wet) (fill)		
5	8	3	2	ML	Brown-black sandy silt with occasional gravel and organic matter (soft, wet)	38	
	12	3	3 %F	SP-SM	Gray fine to coarse sand with silt (loose, wet)	18	%F = 7
10	8	5	4 %F	SP	Gray fine to coarse sand with gravel, trace shells, and silt (loose, wet)	12	%F = 4
	18	9	5	SP-SM	Gray medium to coarse sand with silt and trace shells (medium dense, wet)	12	
15	18	24	6 %F			20	%F = 8
	12	18	7 %F	SP-SM	Gray fine to medium sand with silt and shells (medium dense, wet) (beach deposits)	23	%F = 13
20	18	15	8			25	
25				ML	Brown sandy silt with occasional gravel (stiff, wet) (transition zone)		

Note: See Figure 2 for explanation of symbols.

Log of Boring B-8

GEOENGINEERS

Project: Oak Harbor Wastewater Treatment Plant
Project Location: Oak Harbor, Washington
Project Number: 2751-017-01

Figure 7
Sheet 1 of 2

Elevation (feet)	Depth (feet)	FIELD DATA: Interval Recovered (in)	Blows/foot	Collected Sample: Sample Name Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, (pcf)	REMARKS
	25	18	45	9a					18		
				9b			SM	Gray silty fine to coarse sand with gravel (very dense, wet) (till)	21		
	30	5	50/5"	10					11		

Note: See Figure 2 for explanation of symbols.

Log of Boring B-8 (continued)

GeoEngineers

Project: Oak Harbor Wastewater Treatment Plant
Project Location: Oak Harbor, Washington
Project Number: 2751-017-01

Figure 7
Sheet 2 of 2

Start	End	Total Depth (ft)	Logged By	Driller	Drilling Method
Drilled 10/31/2012	10/31/2012	45.5	AJH	Boretec	Hollow-Stem Auger

Surface Elevation (ft)	8.25	Hammer Data	Rope & Cathead 140 (lbs) / 30 (in) Drop	Drilling Equipment	M55 Track-mounted
Vertical Datum	NAD 83				
Easting (X)	1196090.42	System Datum		Groundwater	
Northing (Y)	473762.15			Date Measured	Depth to Water (ft) / Elevation (ft)
Notes:				10/31/2012	3.0 / 5.25

Elevation (feet)	Depth (feet)	Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name / Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, (pcf)	REMARKS
	0								SP	Gray fine to medium sand (medium dense, moist to wet) (fill)			
			12	11		1	▽			Becomes wet	22		
	5												
	10		18	14		2a %F					18		%F = 3
						2b			SP-SM	Gray fine to medium sand with silt and shells (medium dense, wet)	18		
	15		12	15		3					16		
									SP-SM	Gray fine to medium sand with silt, shells, and trace organic matter (medium dense, wet) (beach deposits)			
	20		12	18		4 %F					16		%F = 9
	25												

Note: See Figure 2 for explanation of symbols.

Log of Boring B-9

GeoEngineers

Project: Oak Harbor Wastewater Treatment Plant
Project Location: Oak Harbor, Washington
Project Number: 2751-017-01

Figure 8
Sheet 1 of 2

Elevation (feet)	Depth (feet)	Interval Recovered (in)	Blows/foot	Collected Sample	Sample Name Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, (pcf)	REMARKS
	25	8	18		5					22		
-20								SM	Gray silty fine to medium sand with shells and trace organic matter (loose to medium dense, wet)			
	30	12	12		6					28		
-25		18	9		7a %F				With gravel	20		%F = 30
					7b			SM	Gray silty fine to coarse sand with gravel (medium dense, wet) (transition zone)			
	35	18	14		8			CL	Gray silty clay with trace shells (stiff, wet) (glaciomarine drift)	22		
-30			17		9					26		
	40	4	56		10			SM	Gray silty fine to coarse sand with gravel (dense, wet) (till)			
-35		4	50/6"		11				Becomes very dense	12		
	45	6	50/6"		12							

Note: See Figure 2 for explanation of symbols.

Log of Boring B-9 (continued)

GEOENGINEERS

Project: Oak Harbor Wastewater Treatment Plant
Project Location: Oak Harbor, Washington
Project Number: 2751-017-01

Figure 8
Sheet 2 of 2

Start	End	Total Depth (ft)	Logged By	Driller	Drilling Method
Drilled 10/30/2012	10/30/2012	53	AJH	Boretec	Hollow-Stem Auger
			Checked By		

Surface Elevation (ft)	8.88	Hammer Data	Rope & Cathead 140 (lbs) / 30 (in) Drop	Drilling Equipment	M55 Track-mounted
Vertical Datum	NAD 83				
Easting (X)	1196101.24	System Datum		Groundwater	
Northing (Y)	473632.64			Date Measured	Depth to Water (ft) / Elevation (ft)
Notes:				10/30/2012	2.3 / 6.63

Depth (feet)	Interval Recovered (in)	Blows/foot	Collected Sample	Sample Name / Testing	Water Level	Group Classification	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, (pcf)	REMARKS
0						SOD	2 inches of sod			
						SP	Gray fine to coarse sand with gravel and trace silt (loose, moist to wet) (fill)			
					▽		Becomes wet			
	6	7		1				14		
5	8	7		2				23		
	18	10		3 %F				19		%F = 2
							With trace shells			
10	18	17		4				19		
	18	17		5a				52		
				5b		SP-SM	Gray fine to medium sand with silt and occasional shells (medium dense, wet) (beach deposits)	15		
15	18	12		6 %F		SP-SM	Gray fine to coarse sand with gravel, trace shells, and silt (medium dense, wet)	17		%F = 5
	12	19		7				16		
20	12	16		8		SP-SM	Gray fine to coarse sand with silt, gravel, and shells (medium dense, wet)	15		
25										

Note: See Figure 2 for explanation of symbols.

Log of Boring B-10

GEOENGINEERS

Project: Oak Harbor Wastewater Treatment Plant
Project Location: Oak Harbor, Washington
Project Number: 2751-017-01

Figure 9
Sheet 1 of 2

Elevation (feet)	Depth (feet)	FIELD DATA: Interval Recovered (in)	Blows/foot	Collected Sample	Sample Name Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, (pcf)	REMARKS
	25	4	25		9					15		
-20												
	30	12	2		10			ML	Gray sandy silt with shells (very soft, wet)	26		
-25								SM	Gray silty fine sand with shells (loose, wet)			
	35	18	9		11 %F					23		%F = 19
-30												
	40	12	5		12			ML	Gray clayey silt with sand, occasional gravel, and shells (stiff, wet) (glaciomarine drift)	26		
-35								CL	Gray clay (medium stiff, wet)			
	45	18	*21		13					30		*Blow count overstated
-40												
	50	0	50/6"		14							No recovery
		6	50/2"		15			SM	Gray silty sand with gravel (dense, wet) (till)	21		2 inches with California SPT

Note: See Figure 2 for explanation of symbols.

Log of Boring B-10 (continued)

GEOENGINEERS

Project: Oak Harbor Wastewater Treatment Plant
Project Location: Oak Harbor, Washington
Project Number: 2751-017-01

Figure 9
Sheet 2 of 2

Start	End	Total Depth (ft)	Logged By	Driller	Drilling Method
Drilled 10/31/2012	10/31/2012	41	AJH Checked By	Boretec	Hollow-Stem Auger

Surface Elevation (ft) Vertical Datum	8.61 NAD 83	Hammer Data	Rope & Cathead 140 (lbs) / 30 (in) Drop	Drilling Equipment	M55 Track-mounted
Easting (X) Northing (Y)	1197056.12 474404.11	System Datum		Groundwater	
Notes:				Date Measured: 10/31/2012	Depth to Water (ft): 3.5 / Elevation (ft): 5.11

Elevation (feet)	Depth (feet)	Interval Recovered (in)	Blows/foot	Collected Sample	Sample Name / Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, (pcf)	REMARKS
	0							SP	Gray fine to coarse sand with silt (loose, moist to wet) (fill)			
		12	7		1	▽				20		
									Becomes wet			
	5	18	9		2a					15		
					2b					19		
									With trace shells			
		6	5		3 %F					19		%F = 5
	10	12	8		4 %F			SP-SM	Gray fine to coarse sand with silt and shells (loose, wet) (beach deposits)	17		%F = 5
		8	6		5 %F					18		%F = 13
	15	18	11		6			SM	Gray silty fine to medium sand with trace shells (loose, wet) With trace organic matter	21		
	20	12	6		7			SM	Gray silty fine sand with trace shells and organic matter (loose, wet)	21		
	25											

Note: See Figure 2 for explanation of symbols.

Log of Boring B-12

GeoEngineers

Project: Oak Harbor Wastewater Treatment Plant
Project Location: Oak Harbor, Washington
Project Number: 2751-017-01

Figure 10
Sheet 1 of 2

Elevation (feet)	Depth (feet)	FIELD DATA: Interval Recovered (in)	Blows/foot	Collected Sample	Sample Name / Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, (pcf)	REMARKS
	25	18	24*		8					35		*Blow count overstated
-20												
	30	18	12		9a					29		
					9b			SM	Gray silty fine to coarse sand (medium dense, wet) (transition zone)	18		
-25								SM	Gray silty fine to coarse sand with gravel (very dense, wet) (till)			
	35	11	50/5"		10					14		
-30												
	40	8	50/5"		11					13		

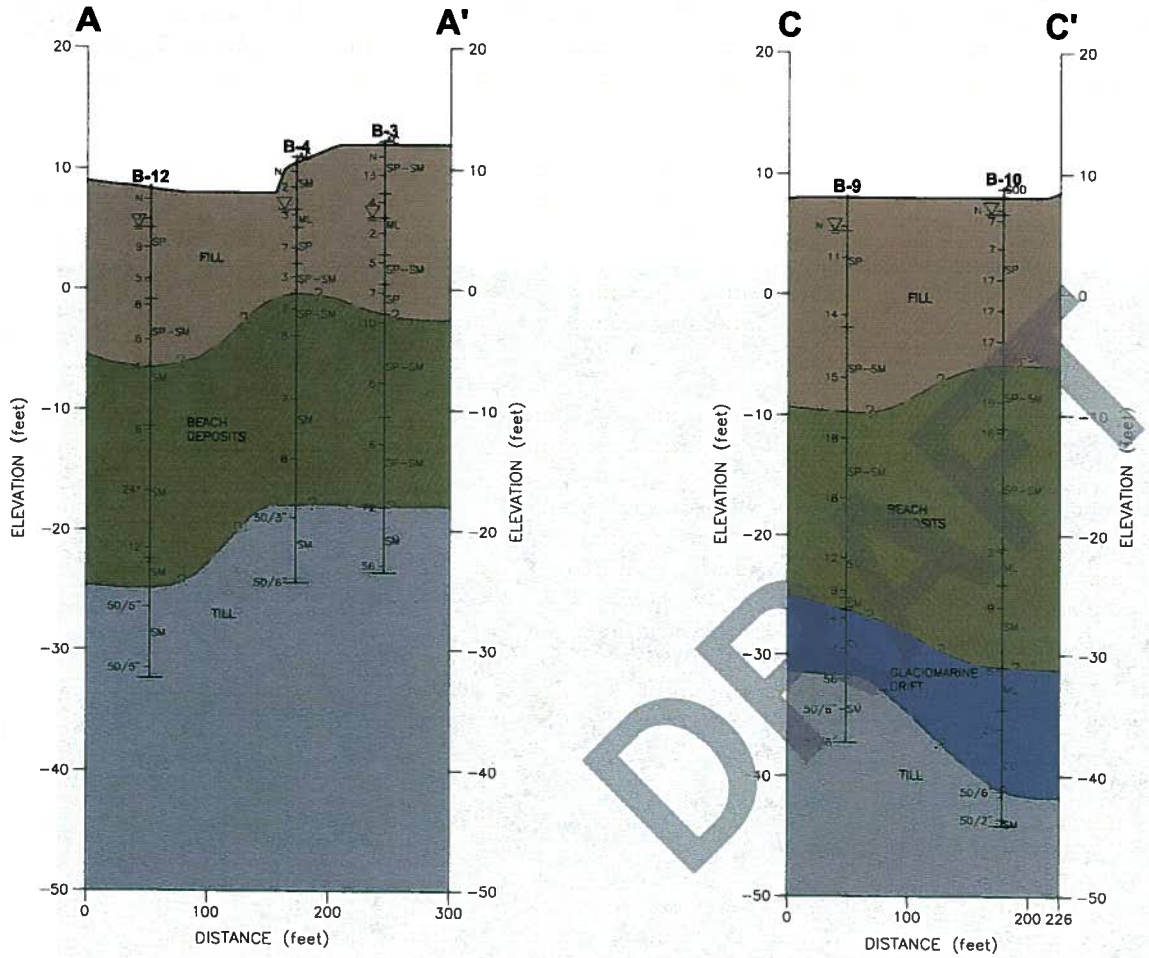
Note: See Figure 2 for explanation of symbols.

Log of Boring B-12 (continued)

GEOENGINEERS

Project: Oak Harbor Wastewater Treatment Plant
Project Location: Oak Harbor, Washington
Project Number: 2751-017-01

Figure 10
Sheet 2 of 2



EXPLANATION:

- B-4 — BORING NUMBER AND APPROXIMATE LOCATION
- 7 — BLOW COUNT
- SM — SOIL TYPE AT SAMPLE LOCATION
- ? — SOIL CONTACT
- GROUNDWATER LEVEL (DURING DRILLING)
- • — BLOW COUNT OVERSTATED

Horizontal Scale in Feet: 100 0 100

Vertical Scale in Feet: 10 0 10

Vertical Exaggeration: 10X

Notes:

1. The subsurface conditions shown are based on interpolation between widely spaced explorations and should be considered approximate; actual subsurface conditions may vary from those shown.
2. Refer to Figure 2 for location of Cross Section.
3. This figure is for informational purposes only. It is intended to assist in the identification of features discussed in a related document. Data were compiled from sources as listed in this figure. The data sources do not guarantee these data are accurate or complete. There may have been updates to the data since the publication of this figure. This figure is a copy of a master document. The master hard copy is stored by GeoEngineers, Inc. and will serve as the official document of record.

Cross Sections A-A' and C-C'

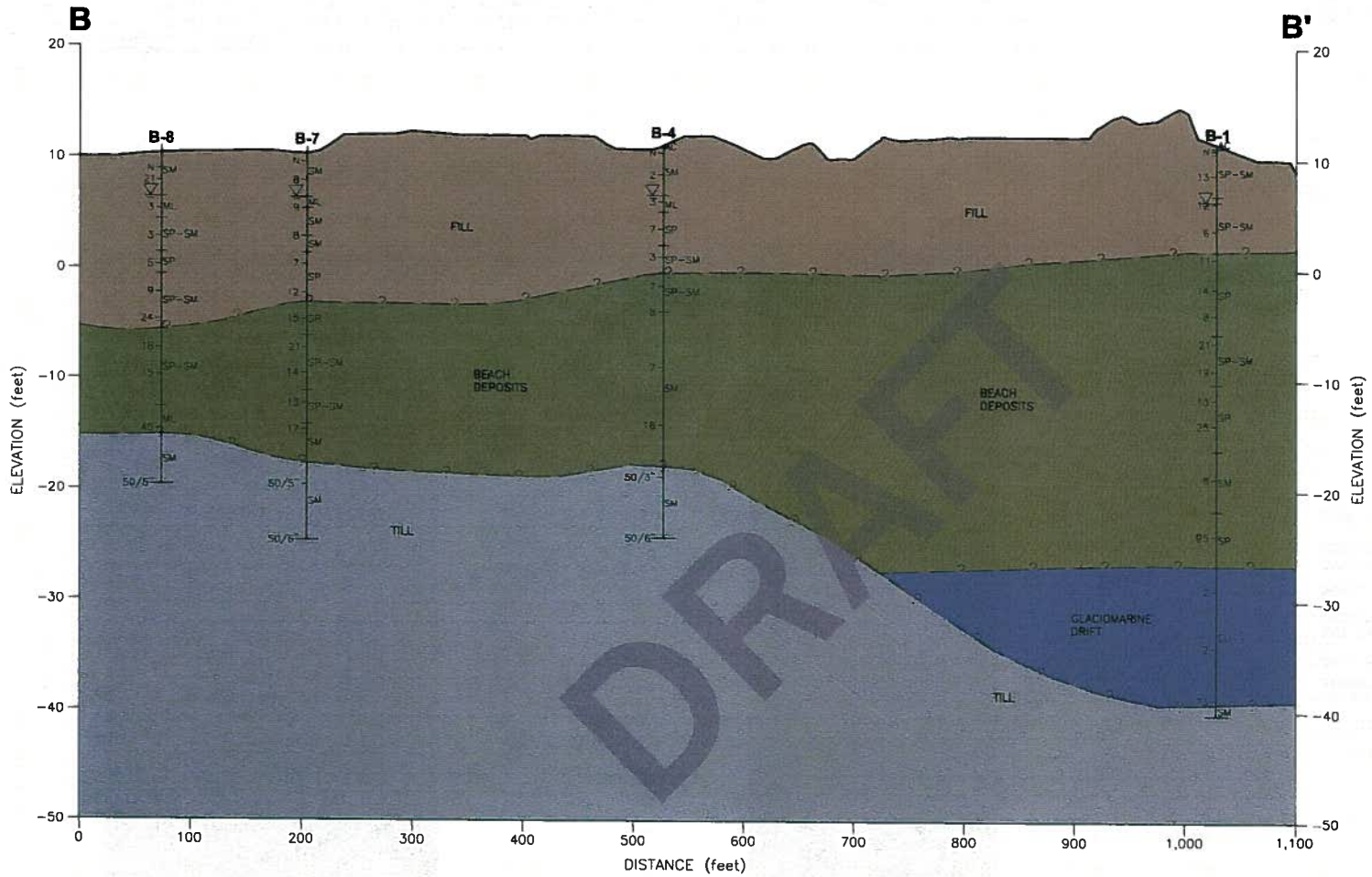
City of Oak Harbor
Windjammer Site Evaluation
Oak Harbor, Washington

GEOENGINEERS

Figure 11

BELLJAH : SCY

P:\0275101701\CAD\0275101701_F3_F4.dwg\TAB:F3 modified on Nov 13, 2012 - 12:06pm



EXPLANATION:

B-4 — BORING NUMBER AND APPROXIMATE LOCATION

7 — BLOW COUNT

SM — SOIL TYPE AT SAMPLE LOCATION

? — SOIL CONTACT

GROUNDWATER LEVEL (DURING DRILLING)

100 0 100
Horizontal Scale in Feet

10 0 10
Vertical Scale in Feet
Vertical Exaggeration: 10X

Notes:

1. The subsurface conditions shown are based on interpolation between widely spaced explorations and should be considered approximate; actual subsurface conditions may vary from those shown.
2. Refer to Figure 2 for location of Cross Section.
3. This figure is for informational purposes only. It is intended to assist in the identification of features discussed in a related document. Data were compiled from sources as listed in this figure. The data sources do not guarantee these data are accurate or complete. There may have been updates to the data since the publication of this figure. This figure is a copy of a master document. The master hard copy is stored by GeoEngineers, Inc. and will serve as the official document of record.

Cross Section B-B'

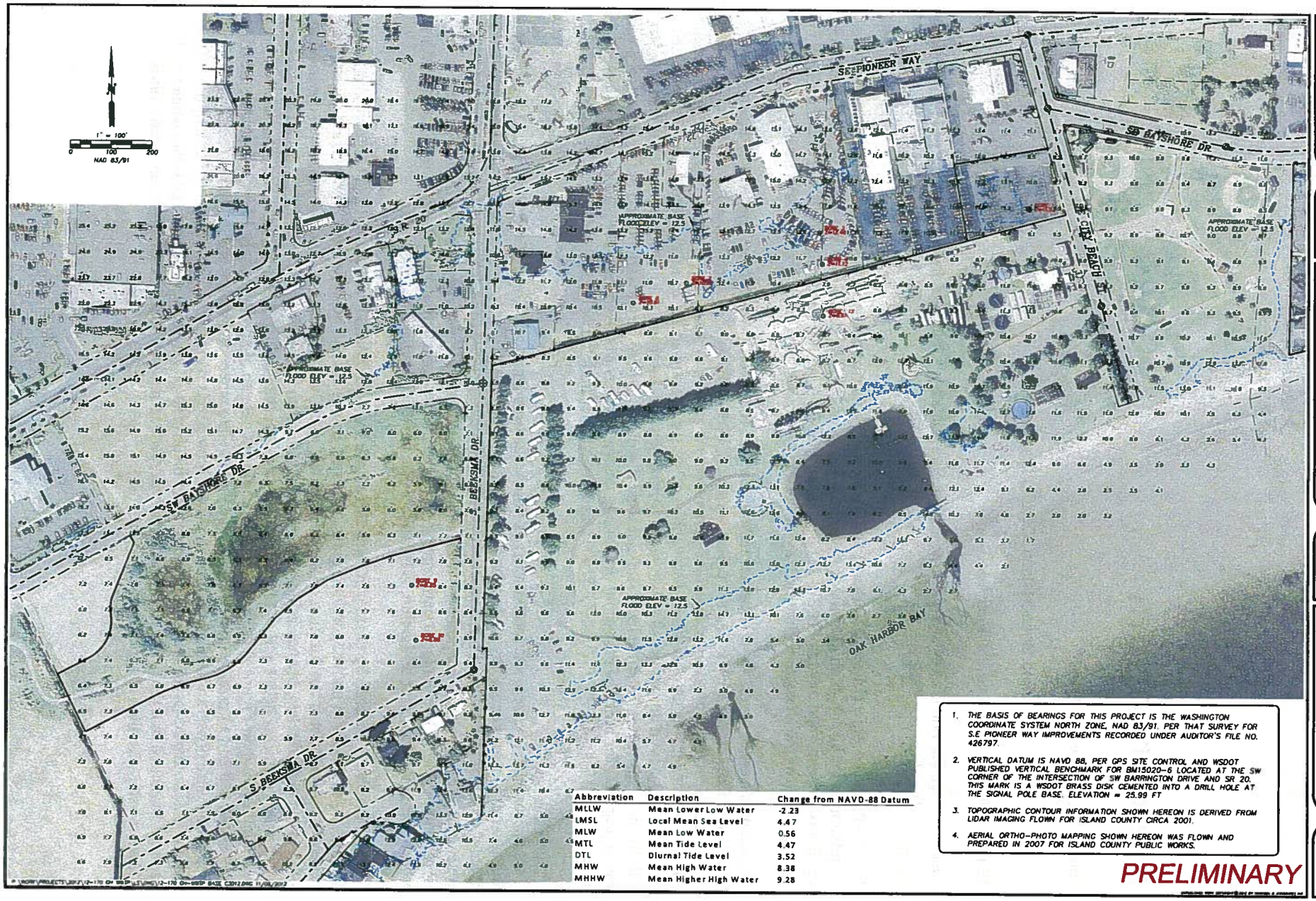
City of Oak Harbor
Windjammer Site Evaluation
Oak Harbor, Washington

GEOENGINEERS

Figure 12

BELLJAH : SCY

P:\32751\01701\CAD\27510170 1_F3_F4.dwg\TAB:F4 modified on Nov 13, 2012 - 12:07pm



Abbreviation	Description	Change from NAVD-88 Datum
MLLW	Mean Lower Low Water	-2.23
LMSL	Local Mean Sea Level	4.47
MLW	Mean Low Water	0.56
MTL	Mean Tide Level	4.47
DTL	Diurnal Tide Level	3.52
MHW	Mean High Water	8.38
MHHW	Mean Higher High Water	9.28

1. THE BASIS OF BEARINGS FOR THIS PROJECT IS THE WASHINGTON COORDINATE SYSTEM NORTH ZONE, NAD 83/91. PER THAT SURVEY FOR S.E PIONEER WAY IMPROVEMENTS RECORDED UNDER AUDITOR'S FILE NO. 426797.
2. VERTICAL DATUM IS NAVD 88, PER GPS SITE CONTROL AND WSDOT PUBLISHED VERTICAL BENCHMARK FOR BM15020-6 LOCATED AT THE SW CORNER OF THE INTERSECTION OF SW BARRINGTON DRIVE AND SR 20. THIS MARK IS A WSDOT BRASS DISK CEMENTED INTO A DRILL HOLE AT THE SIGNAL POLE BASE. ELEVATION = 25.99 FT
3. TOPOGRAPHIC CONTOUR INFORMATION SHOWN HEREON IS DERIVED FROM LIDAR IMAGING FLOWN FOR ISLAND COUNTY CIRCA 2001.
4. AERIAL ORTHO-PHOTO MAPPING SHOWN HEREON WAS FLOWN AND PREPARED IN 2007 FOR ISLAND COUNTY PUBLIC WORKS.

PRELIMINARY

REVISIONS

DWN. BY: MT
CHK. BY:
DATE: 11/2/12
JOB #: 12-170
F/B #: 1-150
SCALE: 1" = 30'

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memorandum

date November 12, 2012

to Anne Conklin and Brian Matson, Carollo Engineers

from Michael Muscari and Lisa Adolfson

subject Oak Harbor Wastewater Treatment Plant Site Selection – Wetland Reconnaissance of Freund Site and Windjammer Park

ESA wetland ecologist (Michael Muscari) conducted a wetland reconnaissance on the Freund Site and on the Windjammer Parks site, both identified as potential locations for the Oak Harbor Waste Water Treatment Plant. ESA was accompanied on October 30, 2012 by Brian Matson (Carollo) and Joe Stowell (City of Oak Harbor). The locations of the sites are within the City limits and are shown on Figures 1 and 2 (attached).

The reconnaissance involved walking throughout the sites (only northwest corner of park site) and making observations of three required wetland parameters: soil, hydrology, and vegetation conditions. Specific indicators must be present for all three of the wetland parameters for an area to meet the definition of a regulated wetland. A manual soil auger was used to make observations of subsurface soil and hydrologic conditions. Only selected areas were observed during the site visit, and a formal determination and delineation of wetlands was not conducted. This reconnaissance level site assessment provides approximate wetland and buffer boundaries which are appropriate for initial planning but not for site design. Results of the site review are discussed below for two areas: Freund Site (TNP R13203-033-5100) and Windjammer Park (TPN R1302-106-0750).

<u>Freund Site</u>

This approximately 6-acre site located west of South Beeksma Drive and north of SW Beeksma Drive. There are no structures or improvements on the site. Three ditches along the perimeter of the site were determined to meet the definition of wetland, and one small area near the northwest corner of the site was determined to potentially meet wetland conditions. The potential wetland area did not meet the wetland definition, but additional observations during late winter or early spring would be needed for a definitive determination. A large wetland, which was constructed for mitigation, is located on the parcel immediately to the north.

Most of the site is covered by pasture grasses and appears to be cultivated for hay or disked on a regular basis. Grass species observed include: orchard grass, ryegrass, bentgrass, and giant fescue). The wetland vegetation criterion was not met at any location on the site, outside of the wetland ditches. Surface water was observed in each of the three ditches, but no surface water or soil saturation within the upper 12 inches was observed at any other areas examined with a soil auger. At one location near the northwest corner of the site (identified as potential wetland on Figure 1) there was soil saturation at a depth of approximately 13 inches. At this location it is possible that soil saturation to the surface may exist in late winter and early spring. Hydric (wetland) soil conditions were observed throughout the site. Low chroma soils with redox features met the description of hydric soil indicators. Based on the landscape position and historic aerial photos showing a large tidal channel in this area, it is assumed that the hydric soil indicators observed are remnant features that have persisted from a time before the site was ditched and cultivated.

The three ditches along the perimeter of the property contained surface water and met criteria for all required wetland parameters (hydric soils, wetland hydrology, and wetland vegetation). The ditch along 400 feet of the west property boundary was approximately 12 feet wide, contained greater than 1 foot of water, an had a slow flow to the south on October 30, 2012. Wetland plants were dominant in the ditch and several aquatic plant species were present. The ditch along approximately 430 feet of the south end of the site was 2 to 4 feet wide and had been recently excavated. This wetland ditch flows west into the larger ditch along the west property boundary. The ditch along approximately 220 feet of the east side of the property was 2 to 3 feet wide and contained a mixture of grasses and low shrubs. This ditch flows north and crosses the footpath through a small pipe, which outfalls to the off-site mitigation wetland to the north.

Windjammer (Charrette)

Observations were also made of a ditch along the northern property boundary of Windjammer Park. The ditch runs for almost 1,000 feet along the north end of the site, appears to straddle the property boundary and may be entirely off-site in some portions. The ditch is narrow at the east and west ends (approximately 2 feet wide), and the central portion (approximately 700 feet) is up to 10 to 12 feet wide. Native wetland plants are dominant in the ditch and surface water was present. Criteria were met for all three wetland parameters. There was no flow in the ditch on October 30, 2012, but it appears that the ditch drains out culverts at both the west and east ends. Approximate wetland boundaries are shown on Figure 1, which are appropriate for initial planning but not for site design. A formal delineation of these wetland areas was not conducted.

Summary and Regulatory Discussion

Based on the conditions observed on October 30, 2012 we determined that three wetlands (wetland ditches) occur on the Freund Site. Additionally, one area near the center of the site is potentially a wetland. Additional field work would be needed to make a definitive determination for this small area. The 1,000 foot-long ditch on the north boundary of Windjammer Park also meets the definition of wetland.

All of the wetland ditches identified on these sites would likely be regulated by the Corps of Engineers as waters of the U.S. This conclusion is based on historic hydric soils around the ditches, landscape position, and historic aerial photographs that show a large tidal channel running through this area. Based on our experience with the Seattle District of the Corps these ditches would be regulated as waters of the U.S. (wetlands or streams), and would be subject to applicable Corps 404 permit and Ecology 401 permit requirements for activities resulting in fill of any wetland areas. However, the Corps has the authority for jurisdictional determinations and should be consulted for a final determination. If direct wetland fill would result from development of the site, the Corps may use Nationwide Permit 39. However, due to the proximity and connection of the Freund site wetlands to tidal wetlands it is possible that Ecology would require an Individual 401 permitting process. Either permitting route, Nationwide or Individual, would require mitigation for wetland impacts. Costs for wetland mitigation including planning, design, permitting, hydrologic studies, site selection, site acquisition, and long-term monitoring and maintenance vary widely. Cost for a wetland mitigation project of this size could fall within the range of $300,000 to $1,000,000 per acre. Oak Harbor Municipal Code (OHMC) follows the State of Washington wetland definition, and the wetland ditches discussed in this memo would meet the state wetland definition. Wetland buffers are required by section 20.24.010 of the OHMC. The width of required buffers is determined based on several habitat and hydrologic factors that would need to be assessed on-site during a wetland delineation. Estimates of the expected range of potential required buffers are shown on the attached figures; the anticipated range is from 50 to 200 feet. A full delineation of the wetland boundaries would be needed to make a definitive determination of the size and location of the wetlands and the extent of the buffers required by the OHMC. The wetland and buffers areas shown on Figures 1and 2 are approximate and should not be interpreted as being accurate.

The OHMC (Section 20.24.030) allows for reduction of the buffer width by up to 25%, given specific requirements are met. Mitigation in the form of buffer enhancement is required for buffer reduction. Buffer enhancement is typically satisfied by planting and maintaining native trees and shrubs in the remaining buffer area. Buffer enhancement costs estimates vary, but typically fall within the range of $150,000/acre for simple plans to $350,000 per acre for more elaborate enhancement involving grading. This cost estimate range is assuming on-site mitigation, if off-site mitigation is needed, costs increase considerably due to site selection process and land acquisition costs.

Conclusions

Wetlands and wet areas were identified at both the Windjammer (Charrette) site and the Freund site. Federal, state, and Oak Harbor permit approvals are required for wetland fill. Additionally, Oak Harbor requires mitigation for wetland buffer impacts. Based on our preliminary environmental evaluation the following conclusions can be made:

Windjammer (Charrette)

- One ditch running along the northern property boundary was identified as a wetland (approximately ¼ acre); a portion of the wetland (4,000 square feet) may need to be filled as a result of the project.
- The ditch does not appear to be connected to other wetlands; therefore the mitigation replacement ratio is likely to be at most 3:1.
- Based on estimated fill requirements, mitigation costs are estimated to be approximately $275,000. An area for this mitigation wetland is needed, likely in the near vicinity of the impacted area.
- Due to the lower degree of connection of the ditch wetland to tidal waters, the risk of permitting delays and/or cost increases due to permitting are expected to be lower when compared to the Freund Site.

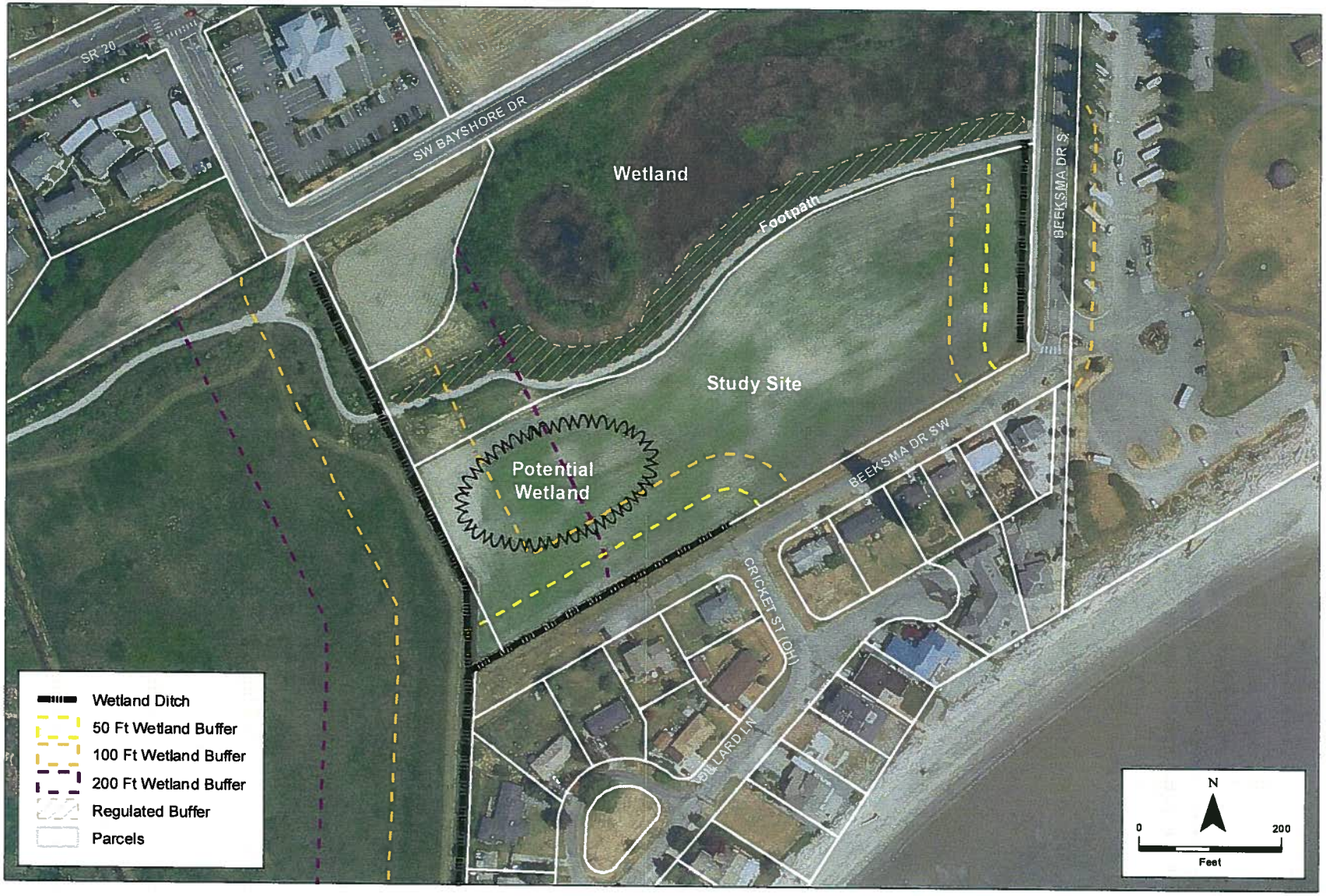
Freund

- Three ditches running along property boundaries were identified as wetlands (approximately 3,000 square feet). Additionally, one potential depressional wetland was identified in the middle of the site. These wetlands would need to be filled as a result of the project.
- The site is also adjacent to a mitigation wetland that is likely protected by a conservation easement. A portion of this wetland (approximately 4,500 square feet) may need to be filled to provide access to the site above the 100-year flood elevation.
- Mitigation requirements will vary depending on the impact area and condition of the wetlands; however, a mitigation replacement ratio of up to 6:1 is possible given the relative importance of previous mitigation wetlands.
- Based on estimated fill requirements, mitigation costs are estimated to be $400,000. An area for this mitigation wetland is needed, likely in the near vicinity of the impacted area.
- Due to the higher degree of connection of the ditch wetland to tidal waters, and due to potential impacts to the existing mitigation wetland, the risk of permitting delays and/or cost increases due to permitting are expected to be higher when compared to Windjammer Charrette site.

Limitations

Within the limitations of schedule, budget, scope-of-work, and seasonal constraints, we warrant that this study was conducted in accordance with generally accepted environmental science practices, including the technical

guidelines and criteria in effect at the time this study was performed. The results and conclusions of this memo represent the authors' best professional judgment, based upon information provided by the project proponent in addition to that obtained during the course of this study. No other warranty, expressed or implied, is made.



SOURCE: ESA 2012; Island County, 2010; Aerials Express (2009) (Aerial).

NOTE: Wetland boundaries were not delineated. Wetland ditches, wetlands, and buffers are approximate only.

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Figure 1
Study Site

SOURCE: ESA 2012; Island County, 2010; Aerials Express (2009) (Aerial).

NOTE: Wetland boundaries were not delineated. Wetland ditches, wetlands, and buffers are approximate only.

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Figure 2
Windjammer Park