Pali Consulting

November 11, 2021

MEMORANDUM

Windsor Engineers
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REGISTERED PROFESSIONAL ENGINEER
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OREGON
JAN. 12, 1999
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EXPIRES 12/31/2023

Preliminary Geotechnical Evaluation
Cannon Beach Seismic Valves
Cannon Beach, Oregon
Pali Consulting Project #074-22-008

1.0 INTRODUCTION

Pali Consulting, Inc. (Pali Consulting) presents this preliminary geotechnical evaluation for the proposed seismic valves replacement project (Project) in Cannon Beach, Oregon. The Project consists of the installation of automatic shut-off valves at three different reservoirs in Cannon Beach, the Main Tank, the North Zone Water Tank, and the South / Tolovana Water Reservoir. Some valves will be placed in new concrete vaults and others in existing vaults. Additionally, Windsor Engineers (Windsor) is considering installing flex-tend valves next to the reservoirs to prevent the pipes from shearing off in the event of an earthquake. Windsor requested that we complete an evaluation of geologic conditions and provide geotechnical recommendations for design and construction of the valves . The location of the reservoirs is shown on Figure 1. Our work was completed in general accordance with our master services agreement with Windsor, dated April 1st, 2021, and Task Order #06, dated July 25th, 2022.

2.0 BACKGROUND

We understand that piping between the tanks and vaults will be replaced with new HDPE pipe at all locations. At the Main Reservoir, the existing vault will be abandoned and a new one installed approximately 10 to 15 feet from the northwest corner of the tank. At the North Reservoir, the existing vault will be reused and will not need to be replaced, relocated, or expanded. At the South / Tolovana

Reservoir, the existing vault will be abandoned and a new one installed; its exact location has not yet been determined at the time of this report but is anticipated to be near the existing vault.

2.1 GEOLOGY

The geology of the reservoir sites is mapped on the Oregon Department of Geology and Mineral Industries' (DOGAMI) website (https://gis.dogami.oregon.gov/maps/geologicmap/#, accessed September 2022). The website maps the all three reservoirs within Miocene-aged turbidites of the Astoria Formation.

The closest mapped faults to the reservoirs occur approximately 3.5 miles west of the sites, as part of an offshore fault known as Fault H (Personius, 2002). It is a 49 km long normal / left lateral fault that trends E-W and dips to the south. Fault H is mapped as multiple fault strands in poorly consolidated accretionary wedge sediments on the continental shelf. The most recent activity on the fault is estimated to have occurred in the latest Quaternary (<15 ka), and a slip rate of greater than 5.0 mm/yr is estimated (Geomatrix Consultants, Inc., 1995).

We reviewed well logs at and near the sites as documented in the geotechnical reports produced for reservoir construction, and on the Oregon Water Resources Department website (https://apps.wrd.state.or.us/apps/gw/well_log/, accessed September 2022). Summaries of the well logs are given in Table 1.

Table 1: Summary of Well Logs

Site	Well Logs Reviewed	Geology	Standing Water Level
Main Reservoir	Cornell, Howland, Hayes, and Merryfield report dated September 6th, 1973. Clatsop county well report CLAT_50469.	Medium stiff silty clay to 7 feet underlain by stiff clay to 50 feet. A nearby well reports sandstone layers <10 feet thick at approximately 30 and 140 feet bgs.	Observed at 5-7 feet at site and at 63 feet in a nearby well. Report notes that further monitoring would be necessary to accurately determine ground water levels. It is unknown if this was completed.
North Reservoir	GeoEngineers report dated June 2nd, 1998. Clatsop county well report CLAT_498.	Approximately 1 foot of topsoil underlain by weathered siltstone to 41.5 feet bgs	Groundwater not observed at site (max exploration depth 41.5 ft), observed at 20' bgs in a nearby well.

Tolovana Reservoir	Kelly / Strazer Associates report dated April 27, 1985. Clatsop county well reports CLAT_55081 and CLAT_55226	Stiff to very stiff clayey silt to up to 20 feet bgs (average approximately 6 feet bgs) overlying in-place weathered basalt to 44.6 feet at the reservoir site. Nearby well reports found silt and clay to depths of up to 150 feet.	Groundwater not observed at site (max exploration depth 44.6 ft) or in nearby wells.

2.2 LiDAR, Topography and Landforms

We interpreted digital information related to landforms at the sites, including LiDAR and topographic maps available on the DOGAMI website (https://gis.dogami.oregon.gov/maps/hazvu/, accessed September 2022) and on Google Earth. A summary of our findings and interpretation at each site are provided below.

Main Reservoir Site

LiDAR-based hillshade imagery shows that the Main Reservoir site is situated on a flat pad excavated into the crest of an E-W trending ridge. The natural ground surface slopes down gently to the north, south, and east, and sharply up over a short cut slope to the west. The slopes surrounding the site appear generally smooth and planar to divergent, with short convergent areas south of the site associated with the initiation points of nearby streams. No indicators of instability were observed in air photos from the years 1994-2021.

North Reservoir Site

LiDAR-based hillshade imagery shows that the North Reservoir site is situated on a flat pad excavated atop a natural hill. The ground slopes gently down to the north, south, and west, and moderately down to the east. The slopes surrounding the site appear generally smooth and planar to divergent, and no indicators of instability were observed in air photos from the years 1994-2021.

South / Tolovana Reservoir Site

LiDAR-based hillshade imagery shows that the Tolovana Reservoir site is situated on a flat pad excavated into the nose of an east-west trending ridge. The ground slopes steeply up on the east side of the reservoir to form the ridge, and down on the west side of the reservoir pad towards US-101. The slopes surrounding the site appear generally smooth and planar, and no indicators of instability were observed in air photos from the years 1994-2021.

2.3 Geotechnical Reports

We reviewed geotechnical reports completed for design and construction of each of the reservoirs. Significant findings from each report are summarized below:

Main Reservoir / Cornell, Howland, Hayes, and Merryfield report dated September 6th, 1973

- One drilled boring was completed to a depth of approximately 50 feet at the site in August of 1973.
- The boring was located approximately 10 to 15 ft to the southeast of the proposed vault location. At the depths of interest (from the surface to approximately 5 feet below current ground surface (bgs)) the boring log shows stiff consolidated clay (Astoria Formation).
- Slopes in the vicinity of the site were not evaluated for stability in the report.

North Reservoir / GeoEngineers Report dated June 2nd, 1998

- Two drilled borings were completed to depths of 41.5 and 6.5 feet deep at the site in May of 1998.
- The closest boring to the current vault location is approximately 65 ft to the southwest. A second boring was completed approximately 80 feet to the north of the vault location. At the depths of interest (approximately 5 feet bgs, accounting for topography), both boring logs show hard weathered siltstone.
- Slopes in the vicinity of the site are moderate with gradients typically between 10 and 20 degrees.
- No signs of instability were observed at the site except a possible slump feature located about 500 feet northeast of the current vault location. The report concluded that the possible slump feature was small and localized, and unlikely to affect the reservoir or its immediate surroundings.

Tolovana Reservoir / Kelly / Strazer Associates reports dated April 27, 1985, and January 29, 1986

- Two hand augers were completed to depths of 1.5 and 3.3 feet at the site in April of 1985. An additional five test pits were completed to depths of between 10 and 14 feet and five rock cores were completed to depths of between 20 and 44.6 feet in late 1985.
- The closest explorations to the current vault location are TP-3 and B-5, which are located approximately 15 ft to the southeast and 15 ft to the northwest of the current vault, respectively. At the depths of interest (approximately 5 feet bgs), exploration logs show a gradational zone between moderately weathered, highly fractured basalt, and slightly weathered, fractured basalt.
- Based on subsurface explorations and observations of nearby outcrops and roadcuts, the authors concluded that the reservoir ridge consists of an unmapped basaltic dike.
    - The approximate southern limit of the dike in the vicinity of the reservoir was verified and mapped in Figure 23 of the 1986 report (Figure 2).
    - The northern limit of the dike was not established, but borings and test pits encountered basalt bedrock to at least the northern edge of the present reservoir location.
- Native slopes in the vicinity of the site are moderate with gradients of 16 up to 22 degrees.
- No signs of instability were observed at the site except for slight surficial soil creep, as indicated by slight downslope tilting of young conifers.

2.4 Geologic Hazards

Geologic hazards were reviewed on the DOGAMI HazVu website (https://gis.dogami.oregon.gov/maps/hazvu/, accessed September 2022). We found the following regarding hazards mapped at the sites:

Main Reservoir

- Subject to severe shaking from Cascadia earthquakes.
- Subject to very strong shaking from local earthquakes.
- Above the statutory tsunami inundation line
- Not within the coastal erosion hazard zone
- The site is mapped as part of a large deep-seated landslide complex.
- The site is mapped to have very high landslide potential.
- The site is considered to have no soil liquefaction potential.
- The site is not within a flood hazard zone.

North Reservoir

- Subject to severe shaking from Cascadia earthquakes.
- Subject to very strong shaking from local earthquakes.
- Above the statutory tsunami inundation line
- Not within the coastal erosion hazard zone
- The site is mapped as part of a large deep-seated landslide complex.
- The site is mapped to have very high landslide potential.
- The site is considered to have no soil liquefaction potential.
- The site is not within a flood hazard zone.

Tolovana Reservoir

- Subject to severe shaking from Cascadia earthquakes.
- Subject to very strong shaking from local earthquakes.
- Above the statutory tsunami inundation line
- Not within the coastal erosion hazard zone
- The site is mapped as part of a large deep-seated landslide complex. However, the Kelly / Strazer Associates reports note that the geology at the reservoir site is an unmapped basaltic dike and as such should not be considered part of the mapped landslide.
- The site is mapped to have high to very high landslide potential. However, landslide potential mapping is based on low-resolution geologic mapping which does not capture the basaltic dike at the site. As such, the site is likely more stable than reported by HazVu.
- The site is considered to have no soil liquefaction potential.
- The site is not within a flood hazard zone.

Although landslide potential is mapped as high, this is due to the widespread mapping of the area around Cannon Beach as within a deep-seated landslide complex. Based on the site-specific geotechnical reports, landslide potential appears to be low at each site.

3.0 CONCLUSIONS

Our conclusions concerning the new valves and/or vaults at each site are summarized in the following sections.

3.1 SUBGRADE CONDITIONS AND EXCAVATIONS

Our evaluation of subgrade conditions for vaults and valves found that the subgrades should be suitable at each reservoir site. Loose material should be removed from excavation bases, so the subgrade consists of firm undisturbed soil or rock. A 6-inch layer of ¾” minus well-graded crushed rock placed on the subgrade and compacted to a well-keyed condition will help protect the subgrade from light foot traffic and provide an even surface for installation of the valves and vaults.

Specific conditions expected at each location and our opinion of excavating soils at each reservoir are detailed below.

3.1.1 MAIN RESERVOIR

Publicly available mapping and the 1973 geotechnical report indicate that the entire reservoir site is underlain by medium stiff silty clay which grades to stiff consolidated clay (Astoria Formation) at an approximate depth of seven feet below the native ground surface. As-built site plans indicate that the site was excavated to depths of between 20 feet on the west to 10 feet on the east to create a flat pad for the reservoir, then backfilled with compacted earth around the edges of the reservoir to a final grade of approximately 2 to 5 feet below the original ground surface. The lateral extent of the compacted fill is unknown, but likely extends 5 to 10 feet from the edge of the tank.

Depending on the lateral extent of the fill in the northwest corner, the proposed vault location is likely in a zone of native stiff clay (Astoria Formation) but may be in a zone of compacted fill composed of on-site clay. Construction records were not available to confirm compaction of the fill, but it is very likely that the fill was compacted to meet the standards of structural fill. Our review finds that both subgrade materials are expected to be suitable to support the new vault. If in fill there is more of a risk of subgrade soils being soft, but the risk is low, in our opinion. Excavation within either material should be readily accomplished by conventional earthmoving equipment in good working condition.

3.1.2 NORTH RESERVOIR

Publicly available mapping and the 1998 geotechnical report indicate that the entire reservoir site is underlain by weathered siltstone underneath a thin (6 inch to one foot) layer of silty topsoil. As-built site plans indicate that the site was not excavated beyond stripping the topsoil and minor cuts / fills as necessary to level the reservoir pad. Based on this information and the position of the vault relative to the tank, we find that the current vault is embedded in native weathered siltstone. Photos of the current vault do not appear to show distress or other signs of instability. It is our opinion that this vault may be re-used for the new valves in its current condition without modifications.

3.1.3 South Reservoir

Publicly available mapping and the 1985 and 1986 geotechnical reports indicate that the reservoir site is underlain by a basaltic dike. The northern extent of the dike is unknown but subsurface explorations indicate it continues at least as far as the northern edge of the reservoir site. The southern extent of the dike is approximately mapped as shown on Figure 2. South of the dike the bedrock is mapped as Astoria Formation overlain with up to four feet of silty colluvium.

The current vault is situated close to the southern edge of the basalt dike, as mapped. As-built site plans indicate that the site was excavated to approximately 15 feet below original grade in the vicinity of the current vault, indicating that it is currently founded in native weathered basalt. We understand you plan to abandon the current vault and construct a new vault nearby, at similar depths. Due to the current vault's proximity to the edge of the dike, constructing a new vault to the north or west of current vault will likely result in embedment within the weathered basalt, while constructing it to the south or east of current location may result in embedment within weathered siltstone/sandstone of the Astoria Formation.

Our review finds that both subgrade materials will be suitable to support the new vault. The basalt is likely to be more difficult to excavate and may require heavier construction equipment such as a hydraulic pick on a trackhoe. Excavation within the Astoria Formation should be readily accomplished by conventional earthmoving equipment in good working condition.

3.2 Trenching and Backfill

Trenches are expected to hold vertical sidewalls to 4 feet deep, unless groundwater inflow or zones of soft fill (Main Reservoir) are encountered. Trenches deeper than 4 feet should be laid back per Occupational Safety and Health Administration (OSHA) guidelines or adequately shored. Soils will generally be OSHA Type A for excavation purposes which allow maximum gradients of 1 horizontal to 1 vertical (1H:1V) for temporary slopes. The contractor should be responsible to confirm the soil type during construction, be responsible for site and worker safety, and protect site facilities if excavations will be completed within the influence zones of site facilities to remain. If shoring is selected, the contractor should be responsible to provide shoring to adequately support the excavation sidewalls.

Backfill should be completed per the pipe manufacturer's recommendations within the pipe zone and per the latest edition of the Oregon Department of Transportation (ODOT) Standard Specifications for Construction (SSC) above the pipe zone. Depending on the overlying use, we recommend backfill above the pipe zone consist of native soils in non-structural areas or imported granular fill in structural areas.

In structural areas, imported granular fill should be pit or quarry run rock, crushed rock, or crushed gravel and sand and should meet the specifications provided in SSC 00330.14 – Selected Granular Backfill or SSC 00330.15 – Selected Stone Backfill. The imported granular material should also be angular, fairly-well graded between coarse and fine material, have less than 10 percent by dry weight passing the U.S. Standard No. 200 Sieve, and have at least two mechanically fractured faces. The material should be placed and compacted in lifts with maximum uncompacted thicknesses of between 6 and 12 inches where light or heavy compaction equipment is used, respectively. During dry weather, the fines content may be increased to a maximum of 20 percent. Compaction should be completed to a minimum of 95 percent of the maximum dry density per the American Society for Testing and Materials (ASTM) D 698.

In non-structural areas, native soils can be used above the pipe zone if they can be properly moisture conditioned and meet the following requirements:

- have a plasticity index (PI) less than 20,
- be free of roots/organics, frozen particles or other deleterious matter, and
- be free of rocks larger than 4 inches.

The native soils should be moisture conditioned to within 5 percent of optimum moisture content and compacted in lifts of between 4 and 8 inches where light or heavy compaction equipment is used, respectively. Compaction should be completed to a minimum of 90 percent of the maximum dry density per ASTM D 698.

Imported granular material used as aggregate base (base rock) beneath the valves or vaults and for vault backfill should be clean, crushed rock or crushed gravel and sand that is fairly-well graded between coarse and fine. The aggregate should meet the specifications of SSC 00641 – Aggregate Subbase, Base, and Shoulder Base Aggregate, with the exception that the aggregate have less than 5 percent by dry weight passing a U.S. Standard No. 200 Sieve based on the minus 3/4-inch fraction and have at least two mechanically fractured faces. The aggregate should have a maximum particle size of 1 inch. The rock should be compacted to 95 percent of ASTM D698 where a 6-inch layer supports the valves or boxes and for vault wall backfall where it is at least 2 feet laterally away from vault walls. Within 2 feet of vault walls, the backfill should be compacted to 90 percent of ASTM D-698 to ensure excessive earth pressures are not placed on the walls during compaction.

3.3 Earth Pressures on Vaults

Where new vaults are installed, they will consist of cast-in-place or precast concrete vaults less than 6 feet deep. The vault walls will be subject to at-rest earth pressures as the short spans will displace sufficient to develop active earth pressures. For this condition we recommended earth pressures be computed as an equivalent fluid pressure of 55 pounds per cubic foot (pcf).

If drainage is not provided, the walls should also be designed to resist full hydrostatic pressure.

4.0 CLOSING AND LIMITATIONS

This report is based on our review of publicly available information, reports and photos provided by you, and our geotechnical experience. No independent subsurface explorations were completed. The opinions and recommendations contained within this report are, therefore, based on evaluation of limited information and should not be construed as a warranty or guarantee of site conditions or performance. Soil conditions can differ from those portrayed in the sources we reviewed, as well as during different seasons, from earth processes, from storms, or other factors that occur after our work has been completed.

Within the limitations of scope, schedule, and budget, our services have been executed in accordance with the standard of care in this area at the time this report was prepared. No warranty or other conditions, express or implied, should be understood.

We appreciate the opportunity to provide this information for you. Please contact us if we can be of further assistance or if you have any questions.

5.0 REFERENCES

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Site photographs taken July 2022, provided by Windsor Engineers.

Attachments: Fig1, Fig2

Document ID: 074-22-008CBSeismicValvesMemo

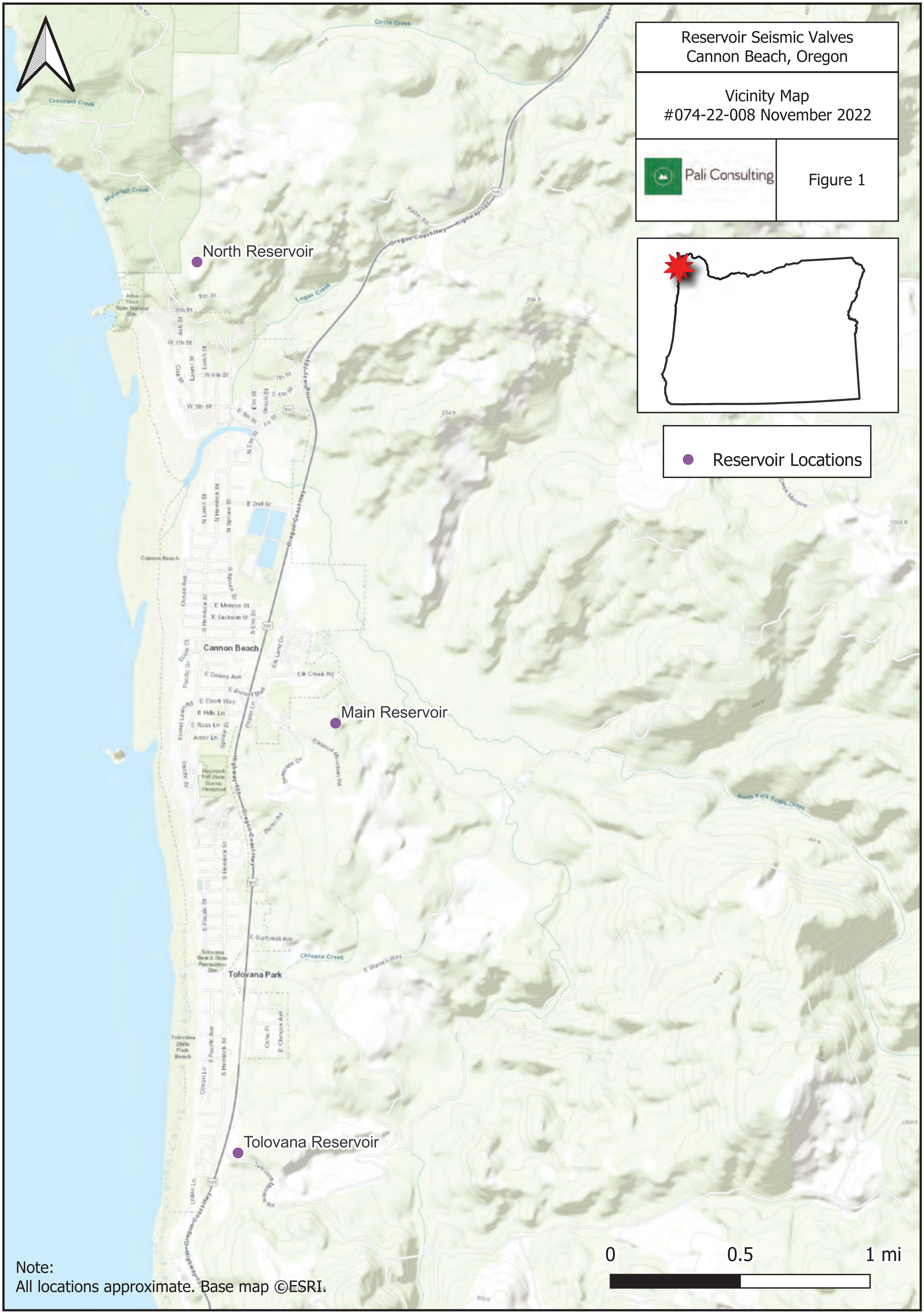
Reservoir Seismic Valves
Cannon Beach, Oregon
Vicinity Map
#074-22-008 November 2022
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Figure 1
Reservoir Locations
North Reservoir
Main Reservoir
Tolovana Reservoir
Cannon Beach
Tolovana Park
0
0.5
1 mi
Note:
All locations approximate. Base map ©ESRI.

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Figure 2

Base map from Kelly / Strazer Associates report dated January 29, 1986

Tolovana Reservoir, Cannon Beach Oregon

Site Map

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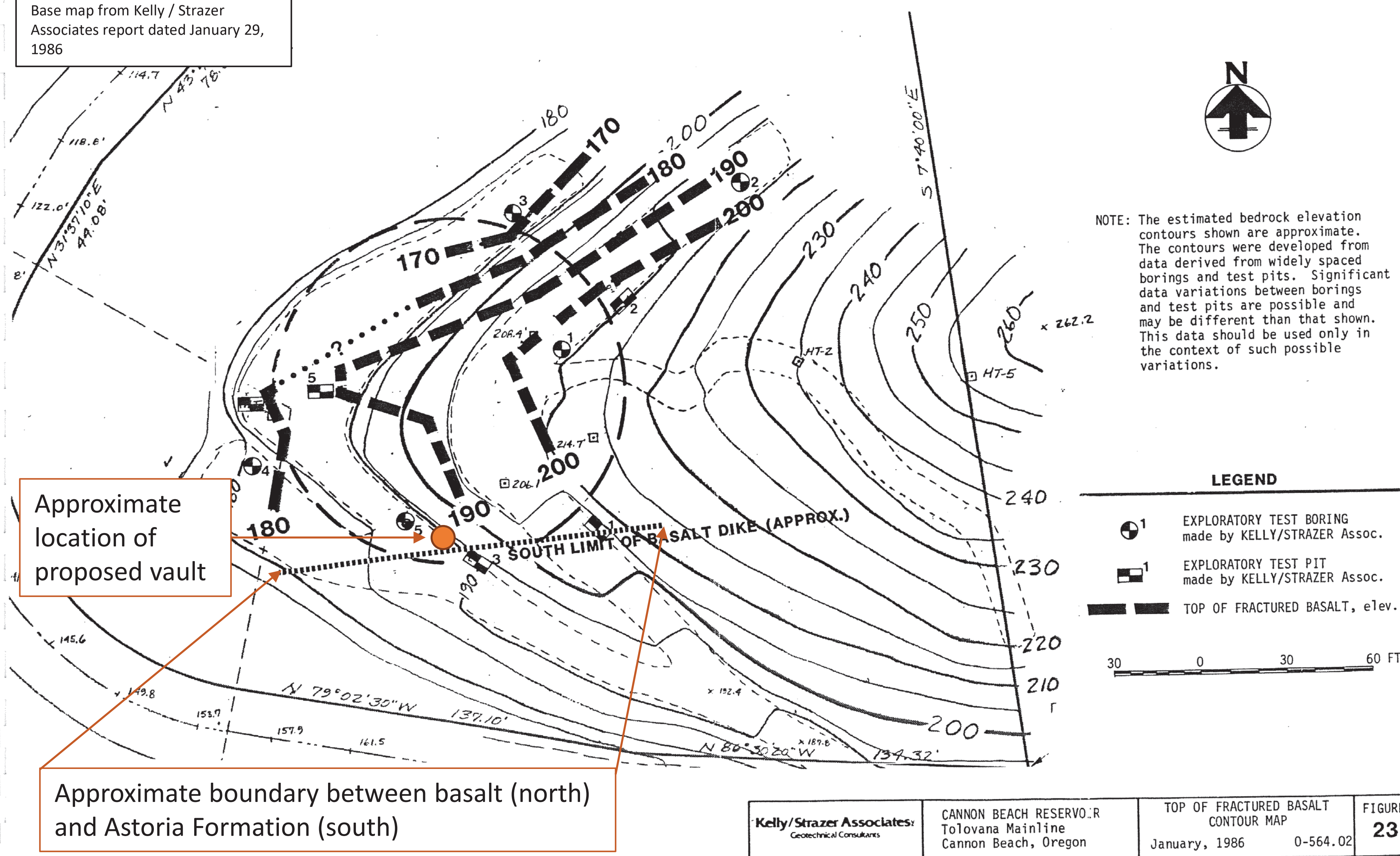

Kelly/Strazer Associates: Geotechnical Consultants	CANNON BEACH RESERVO:R Tolovana Mainline Cannon Beach, Oregon	TOP OF FRACTURED BASALT CONTOUR MAP January, 1986 0-564.02	FIGURE 23