2024 DOBSON RANCH

SEDIMENT SURVEY AND LAKE CHARACTERIZATION

Presented to:

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Introduction and Activity Summary

Aquatic Consulting and Testing, Inc. (AC&T) conducted sediment surveys for the Dobson Ranch Master Association (DRMA), which consisted of seven (7) lakes within the community. These sediment surveys replicated data collected in 2003, and 2014 and were utilized as a method to quantify the rate of sediment accumulation within the DRMA. Sediment accumulation was assumed to be linear, and was then used to project when dredging of the lakes would be required. The sediment surveys were conducted between February 12 and April 04, 2024.

Water depth and sediment composition measurements were made with Lowrance bottom mapping sonar capable of taking more than 2,000 readings per minute. A calibrated sludge judge was used to verify sediment pockets and calibrate the sonar model. Collected data were uploaded to Biobase cloud servers for analysis and map generation. Two different contour maps were generated for each of the lakes. One map displays the total volume of the lake (water depth contours) and the other the sediment composition within the lake. Volume calculations were also conducted using Biobase.

Water and Sediment Depth Survey Results

Contour Maps

The sonar data was used to generate contour maps of lake water and sediment composition. The individual maps for each of the 7 lakes are provided in Appendix A.

Changes in surface acreage and basin volume can be attributed to the use of a much more accurate sonar mapping program. Changes in sediment volume can be attributed to accumulation, compaction or expansion, redistribution, and/or decomposition. Total lake volume and sediment volume data for each lake are listed below (Table 1) and compared to 2014 data (Table 2) and 2003 data (Table 3).

Table 3. 2024 Water and Sediment Data

2024 Lake Number	Lake Surface Acres	Total Volume (Acre Feet)	Total Volume (Cubic Yards)	Sediment Volume (Cubic Yards)	Sediment Volume as % Tot Volume
1	15.0	110	178000	13203	7.42%
2	5.1	26	42600	4028	9.46%
3	3.1	18	29700	3671	12.36%
4	3.3	17	28200	2587	9.17%
5	4.2	21	33200	2622	7.90%
7	35.0	230	372000	35829	9.63%
8	2.6	12	20100	1425	7.09%

Table 2. 2014 Water and Sediment Data

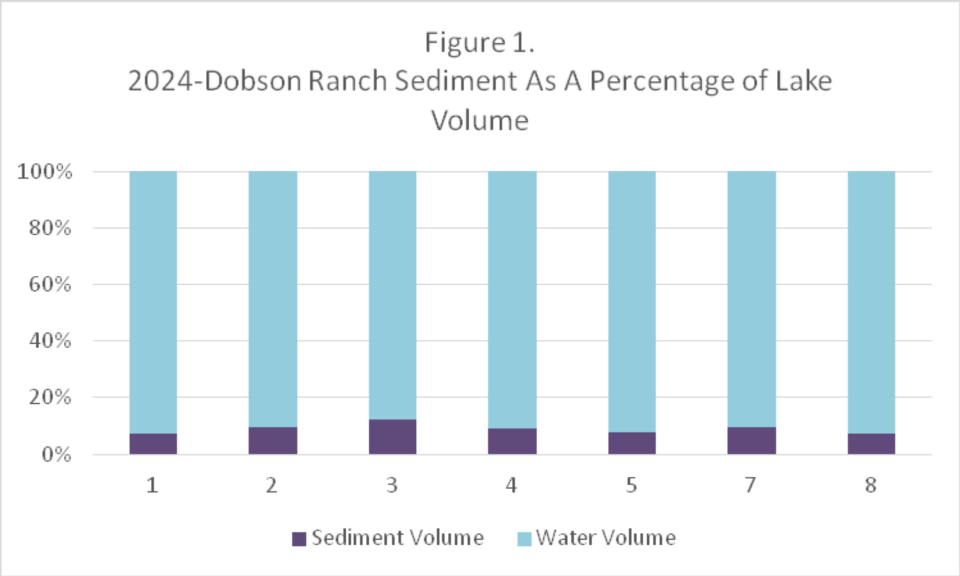
2014 Lake Number	Lake Surface Acres	Total Volume (Acre Feet)	Total Volume (Cubic Yards)	Sediment Volume (Cubic Yards)	Sediment Volume as % Tot Volume
1	16.1	97	156235	10117	6.48%
2	6.0	28	45620	3207	7.03%
3	3.3	21	33437	3049	9.12%
4	3.5	18	28780	2400	8.34%
5	4.3	18	28348	2379	8.39%
6	8.0	39	62200	3708	5.96%
7	38.9	220	353235	28323	8.02%
8	2.7	12	18749	1257	6.70%
Lake Park Village	0.8	4	6978	919	13.17%
The Landings	1.0	3	4086	487	11.92%

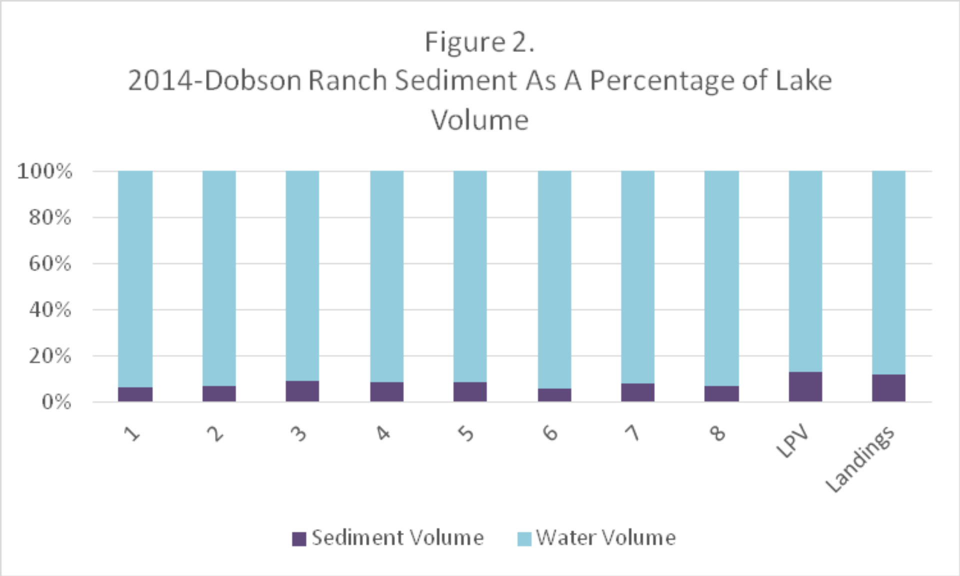
Table 3. 2003 Water and Sediment Data

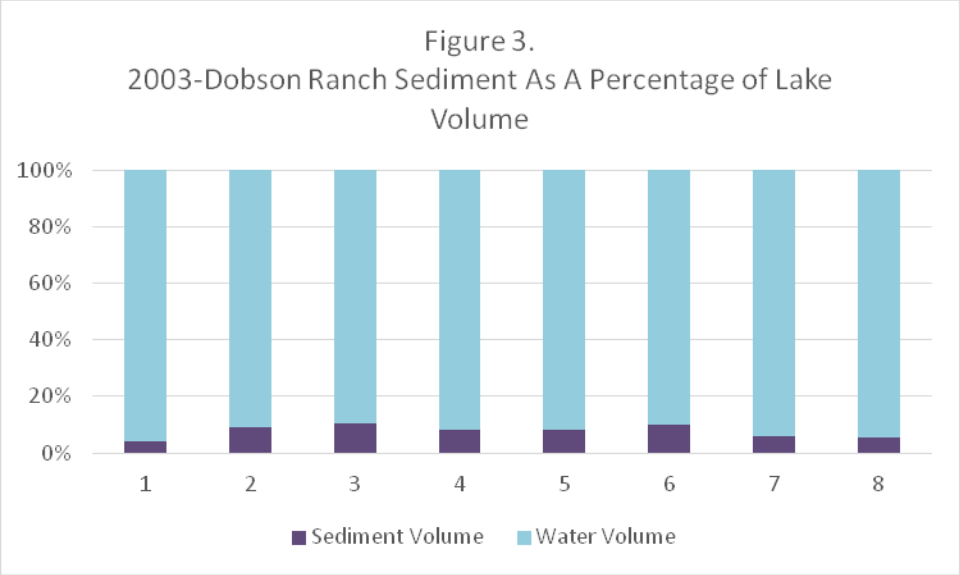
2003 Lake Number	Lake Surface Acres	Total Volume (Acre Feet)	Total Volume (Cubic Yards)	Sediment Volume (Cubic Yards)	Sediment Volume as % Tot Volume
1	16.09	97	156235	6051	3.87%
2	5.96	28	45620	4127	9.05%
3	3.28	21	33437	3491	10.44%
4	3.46	18	28780	2288	7.95%
5	4.31	18	28348	2313	8.16%
6	8.03	39	62200	6247	10.04%
7	38.9	220	353235	20703	5.86%
8	2.72	12	18749	1041	5.55%

Comparison of 2003, 2014, and 2024 Studies

Sediment volume as a percent of the total lake volume is presented below in Figure 1 (2024 data), Figure 2 (2014 data), and Figure 3 (2003 data).





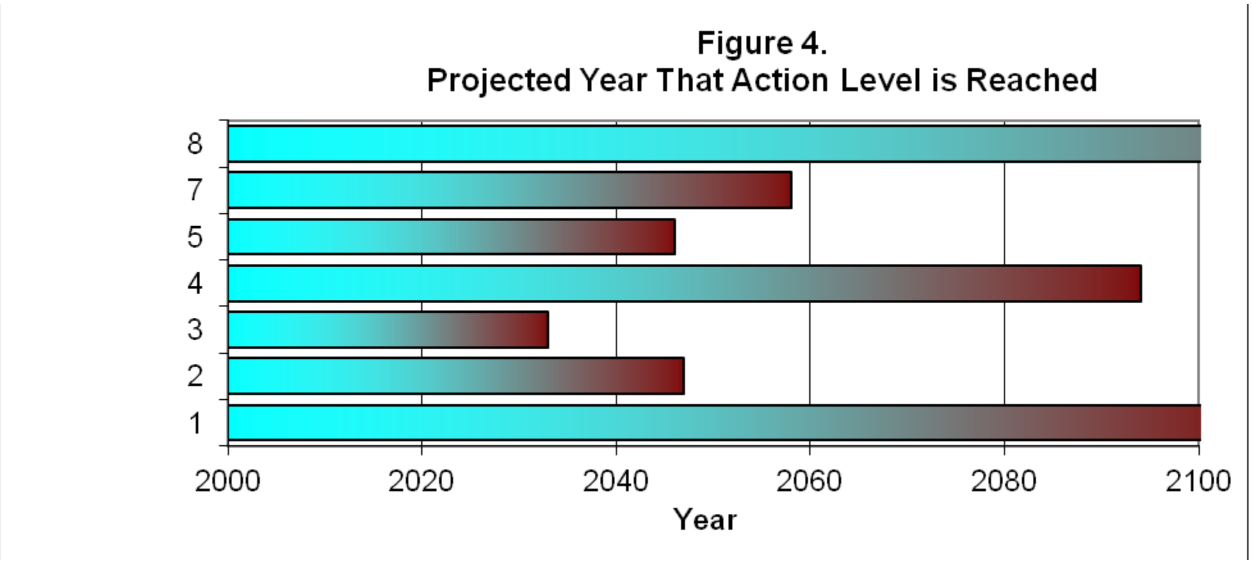


Based on our observations (see Table 4), between 2014 and 2024, sediment accumulation rate among all of the lakes has averaged 0.07% as a percentage of the total lake volume. However, this rate is impacted by the negative accumulation rates that were observed in Lake 2 and Lake 6 (-0.20% and -0.17% respectively). A negative accumulation rate suggests that some combination of sediment compaction and decomposition has occurred in these lakes. In order to establish a projected date for dredging activities to begin, Lakes 1, 2, and 6 as well as the lake at Lake Park Village and the lake at the Landings were assigned the highest rate of yearly accumulation observed (0.28%). Commencement of dredging activities was determined to be necessary when the sediment accumulation reached 20% of the total lake volume (Table 5 and Figure 3).

Table 4. Sediment Volumes and Accumulation Rates

Lake Number	Current % of Total Volume	Rate of Accumulation (per Year)	Year Action Level is Met
1	7.42%	0.09%	2105
2	9.46%	0.24%	2047
3	12.36%	0.32%	2033
4	9.17%	0.08%	2094
5	7.90%	0.32%	2046*
7	9.63%	0.16%	2058
8	7.09%	0.04%	2150

- Based on the Quickest Rate of Accumulation Observed in the Other Lakes (0.32% per Year)



Sediment Removal Options

Upon the realization of the action level it will become necessary to commence sediment removal activities. AC&T was asked to discuss these various removal options and weigh their respective benefits and potential issues. The sediment removal options are as follows:

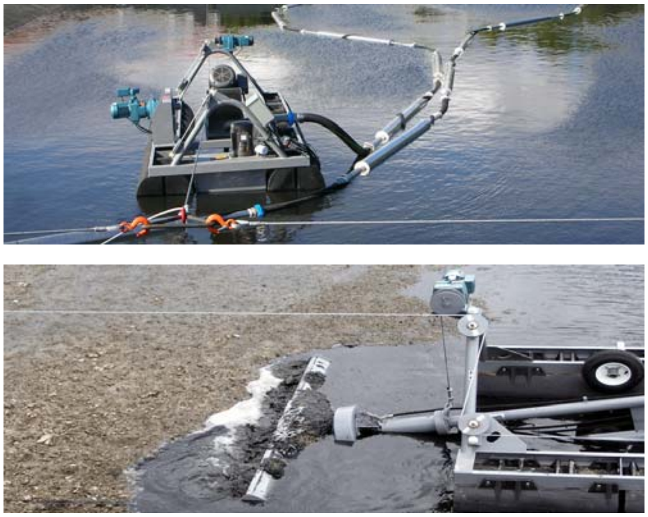
Removal by Moderate Sized Equipment

Removal of the accumulated sediment by moderate equipment (i.e. backhoes, front end loaders, bobcats, and dump trucks) presents a number of benefits. Firstly, it allows for the concentration of the sediment prior to removal due to evaporation once the lake has been drained. This will result in less total waste being moved to the disposal facility which will greatly reduce the cost of disposal. Secondly, removal equipment is fairly innocuous and non-specialized which allows for more options when selecting a contractor to complete the work. This will also help to reduce the overall cost of sediment removal and disposal. A third benefit gained with the use of this style of removal is the ease of access to the entire lake. Once the lake is drained, it will be possible for the equipment to mobilize across the entirety of the lake area. However, there are some potential issues that this removal option presents. Firstly, it is necessary to drain the entire lake in order to complete the removal activities. This presents a number of separate issues including (a) the need to transport the existing fishery to some other location, (b) the potential for undesirable odors to be present while the lake bed is drying, and (c) the length of time required to sufficiently dry out the material. Secondly, equipment needed to remove the sediment will be making multiple trips through the neighborhood surrounding the lake. This presents potential issues such as increased traffic and noise pollution in this area. Thirdly, the lakes are designed as a flow-through system, which means that if an individual lake is drained, it may not be possible to maintain adequate water levels in the lakes downstream of the one being dredged. Finally, removal equipment could potentially damage the lake liner and add additional issues and costs.

Direct Removal by Mechanical or Vacuum/Suction Dredge

Use of dredging equipment to remove the accumulated sediment is another potential option. The dredge may use a shovel-like apparatus to scoop the material and deposit in a holding bin or may use a suction line to essentially vacuum up the material. The latter provides a greater margin of safety with respect to protecting the lake liner from damage. The main benefits of dredging are the ability to retain the existing water level in the lakes throughout the removal process. This avoids the need to relocate the fishery to another lake. However, disturbing the sediment could cause loss of oxygen in the water as bacteria degrade released organic matter incorporated in the sediment and ultimately pose a risk to the fishery. Dredging also eliminates odors associated with an exposed lake bed during the period when the sediment is drying. As with removal by moderate equipment, there will be increased traffic and noise in the area surrounding the lake. In order for dredging to be effective, it will also be necessary to have adequate access for the dredges to enter and leave the lake, which may not be possible due to the residential nature of many of the DRMA lakes. As the sediment is not being dried prior to removal, it may be more difficult to locate disposal locations and it will require sealed transport containers in order to comply with ADOT regulations. Added with the additional cost of having to use specialized contractors with dredging expertise, this option may result in increased sediment removal cost.

Mechanical dredge



Suction dredge (above); dredge auger (below)

Removal by Dredge with an Additional Dewatering Step

Onsite dewatering activities, when used in conjunction with dredging, may help to reduce the overall cost of sediment removal. Dewatering of the sediment may allow for disposal at facilities closer to the community, and may also allow for the use of more traditional hauling equipment. Costs are reduced because the weight of the water is no longer included in the removal cost. Dewatering the sediment onsite could be achieved utilizing two different methods. Firstly, use of specialized roll-off style containers that allow for the draining of bulk materials could be used to achieve this goal. The liquid fraction is returned to the lake. The advantage to this option is that the dewatering container could also serve as the transport container, which would help to reduce the amount of time between dewatering and transport. Secondly, specially designed dewatering bags (i.e. GeoTubes) could be utilized. These tubes achieve a very high level of solidification, and are picked up, transported, and disposed upon the completion of the dredging activities. However, dewatering also presents issues such as the development of odors while the process is being undertaken, the need for a large staging area in which to perform the dewatering step, and increased access to the dredge from multiple locations around the lake.

De-watering devices (left-geotubes, right-dewatering roll-off)

Summary

The following table provides a quick reference summary of the dredging options. An option for partial or a staged complete removal of sediment is also provided. In this case, coffer dams would be installed to isolate areas of a lake. Water in the isolated area could be pumped to the main portion of the lake to expose the sediment. Sediment would be allowed to dry and removed with moderate size equipment. This approach appears to provide the best option in terms of access to the lake, space required for staging of equipment, additional de-watering (if desired), odor minimization, and protection of the fishery.

Process	Project duration	Fishery adverse impact	Level of complexity	Odor generation	Relative removal cost	Relative disposal cost	Access requirement
Moderate size equipment-entire lake	Long	High	Low	High	Low	Moderate	Low
Moderate size equipment- partial or staged entire lake	Long	Low	Low	Low	Low	Low to moderate	Low
Mechanical Dredge	Short	High	Moderate	Moderate	High	High	Moderate
Suction Dredge	Short	Low	Moderate	Low	High	High	Moderate
	Moderate	Low	High	Low-mod	High	Moderate	High

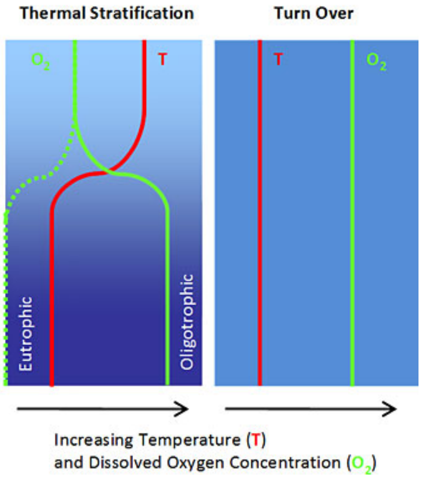
Dredge and dewatering							

Sediment removal behind coffer dam

Nutrient Concentrations - Impact on Aeration and Amur Requirements

Mechanical Aeration

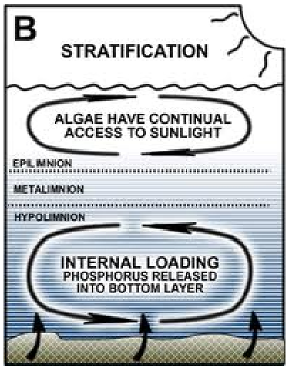
Lake aeration (mechanical vertical circulation) has many benefits. Two of these are to vertically circulate water in order to (1) provide an oxidized water column over the sediment and (2) prevent a defined volume of water from exposure to sunlight for extended period of time.



Lakes become stratified from warming of surface waters by solar radiation. Warm water is less dense than cold water so layers of different temperature water are formed. The density of water changes with temperature; warm water is less dense than cold water. The density difference between the layers produces a physical barrier to movement of dissolved chemical constituents, including oxygen, across the temperature layers. Under this stratified condition, oxygen absorbed at the surface from the atmosphere or produced by algae in the well-lighted portion of the water column cannot move into the deeper water. The deeper water becomes anoxic, leading to loss of aerobic organisms (including fish and invertebrates), and release of nutrients and toxic gases from the sediment. The only way to break thermal stratification (turn over the lake) is with sufficient wind driven currents or by artificial mechanical means.

Mechanical vertical circulation moves poorly oxygenated deep water to the surface where it can absorb oxygen from the atmosphere. This process results in a totally oxidized water column. Establishing an oxidized water column prevents the release of phosphorus (phosphate) from the sediment and oxidizes a portion of the ammonia released into the water column. Nitrates and ammonia are nutrients that stimulate algae growth in the water column. Ammonia can be used as an algal nutrient, but can also become toxic to fish under high pH (>9.0 SU) and warm water (>25 C) conditions.

Phosphorus and nitrogen are accumulated in the sediment via chemical precipitation and settling of dead aquatic organisms (primarily algae). Phosphorus becomes soluble under anoxic (low oxygen and oxidation-reduction potential) conditions present in the sediment. Ammonia is formed by bacterial decomposition of oxidized forms of nitrogen (nitrates). If the water above the sediment becomes low in oxygen, phosphorus would be released into the water column for uptake by algae and chemical oxidation of ammonia is reduced.



Data from this study indicate high concentrations of nitrogen and phosphorus in the sediments of all lakes studied. Therefore, the potential for algal stimulation is present throughout the system. However, data from this study as well as historical data indicate that nutrient concentrations are typically moderate in Lakes 1-8.

Historical vertical profiles of temperature and oxygen have indicated periods of thermal stratification in Lakes 1-8. An aeration study was performed in 2008 and showed Lakes 4 and 5 could benefit from additional vertical circulation, Lakes 1-3 were marginally satisfactory, and Lakes 7 and 8 were satisfactory. More recent analyses have indicated vertical circulation appears satisfactory. No chronic degradation of water quality has been observed.

Amur Stocking Needs

Submerged weeds and filamentous algae are a visual and recreational nuisance. Weeds and filamentous algae tangle

in fishing lines and boat props, weeds usually cause water to become clear and allow the plant growth to be easily observed from the shoreline, filamentous algae can attach to boats and lakes edges making long stringers, and plant fragments and algal filaments can clog intake screens. Mechanical means of removing weeds and algae are costly and difficult to accomplish. Fragmentation of the material spreads the plants and repeated cutting and harvesting is often required. Herbicide applications are more effective means of control, but are not inexpensive. Repeated applications are sometimes required and minimized use of the products, although registered by EPA for the specific use of aquatic weed control, is always a management goal.

White Amur fish (*Ctenopharyngodon idellus*) stocked in the lakes as a means of biologically managing submerged weed and filamentous algae growth. To comply with State regulations, 10-14 inch fish are stocked in the lakes. The fish are aggressive plant eaters though adulthood; feeding slows when they reach ages of 5 or more years and become quite large (20 lbs or more). Stocking densities of 5 to 50 fish are commonly used, depending on the amount of vegetation present and the potential for additional weed growth.

Nutrient concentrations are considered moderate in all lakes examined, with occasional short-term elevated concentrations. Although moderate for Arizona reservoirs, the concentrations are more than adequate to grow filamentous algae and submerged weeds. The extended warm weather and sunshine of Arizona further extends the algae and aquatic weed growing season and can produce large standing crops of plants in a single season. Accumulated sediment in the lakes provides a media for rooted submerged weeds. High concentration of nutrients in the sediment supports the macrophytes, but also provides a medium for filamentous algae growth. Filamentous algae species that grow on the lake bottom are capable of absorbing nutrients associated with the sediment. They often become an aesthetic nuisance when air bubbles are formed during photosynthesis, the bubbles cause sections of the algal mass and bottom sediment to become buoyant, and the material floats to the water surface. Finally, introduction of undesirable aquatic vegetation from the canal system that feeds the lakes, waterfowl, or human activities provides a constant potential for nuisance plant growths.

APPENDIX A

WATER AND SEDIMENT DEPTH CONTOUR MAPS

A-1: 2024 CONDITIONS

BIOBASE

Dobson Lake
2/13/2024

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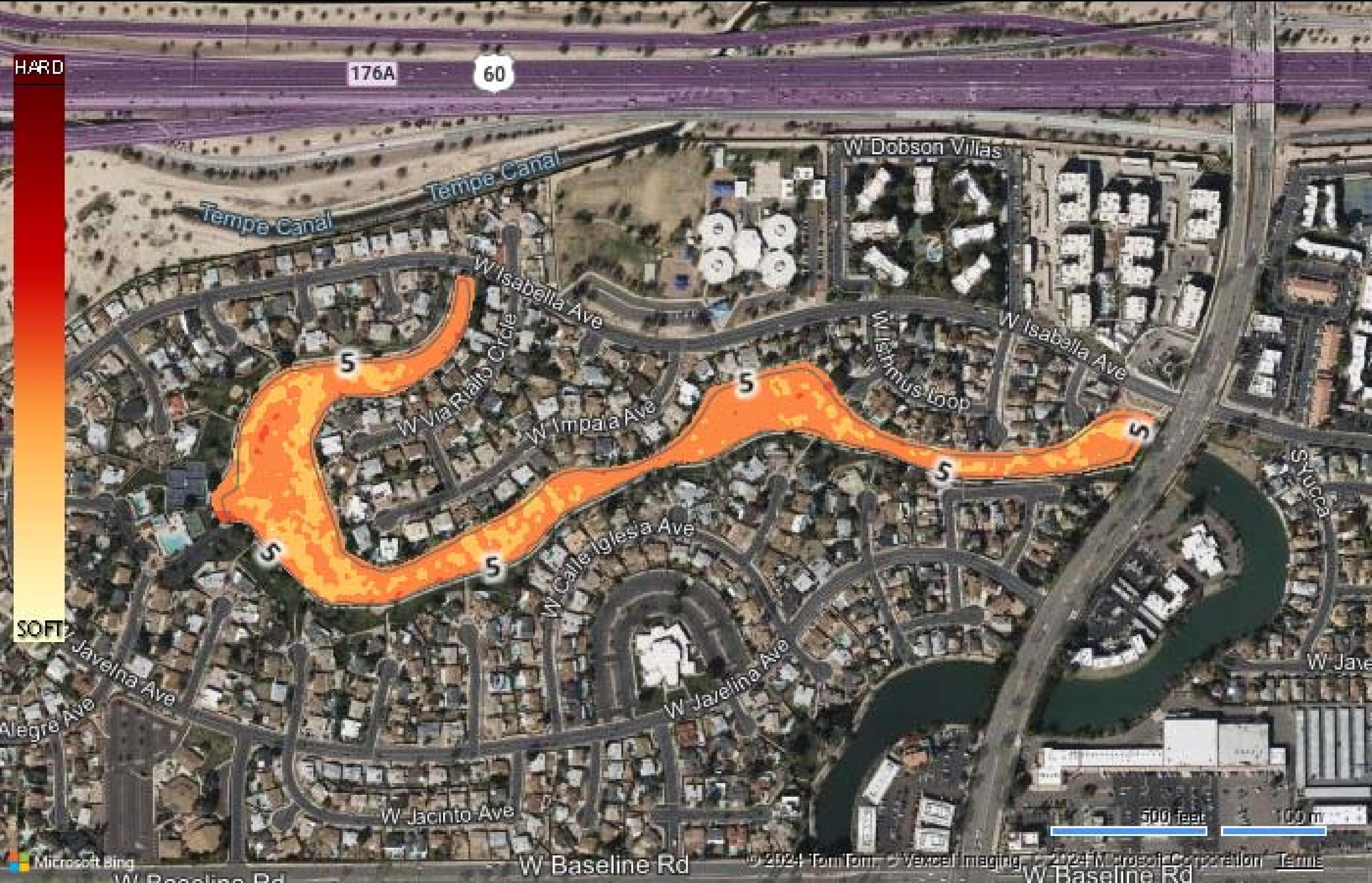

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Dobson Lake
2/13/2024

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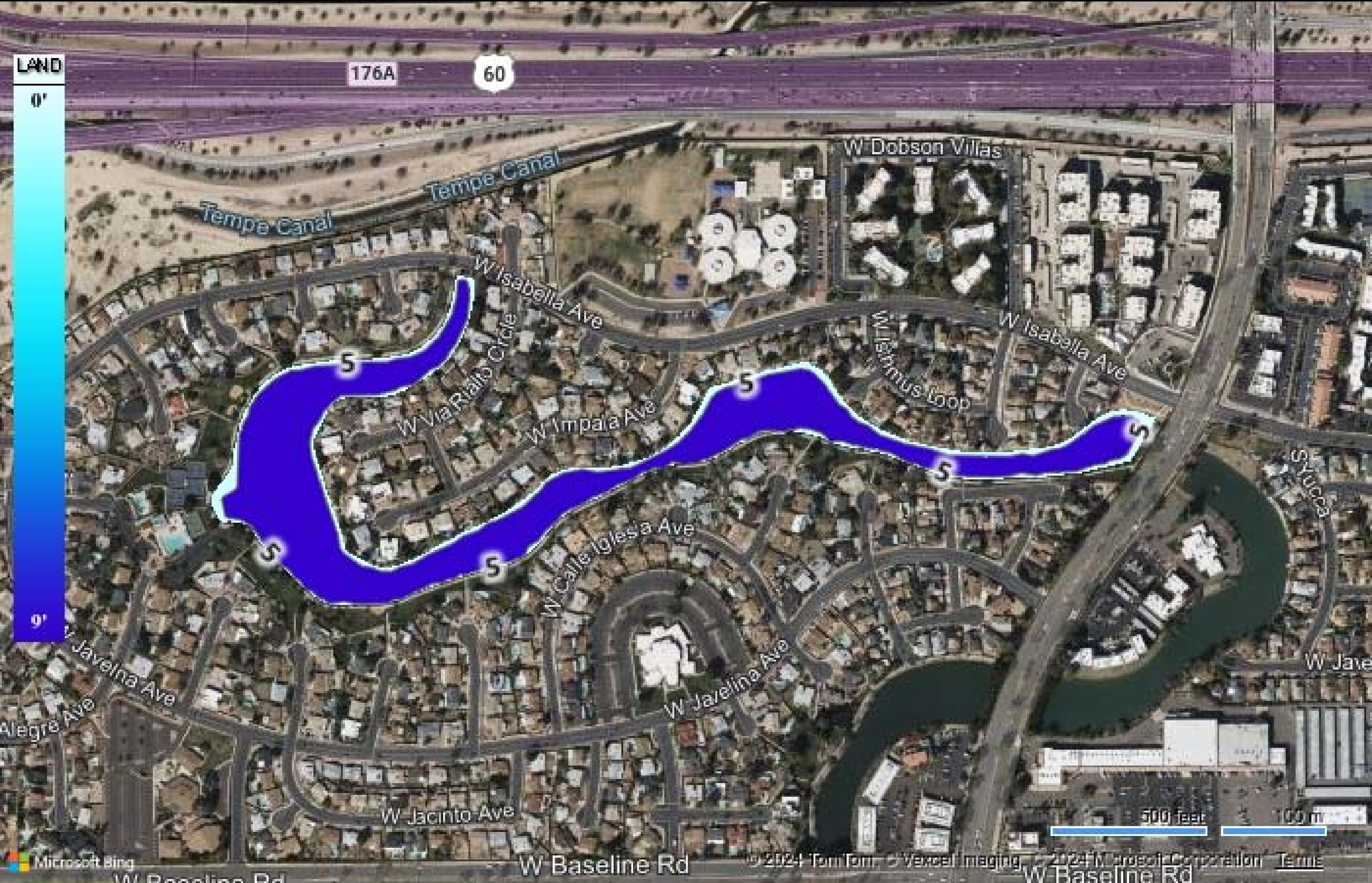

Dobson Lake 2
2/22/2024

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BIO BASE

Dobson Lake 2
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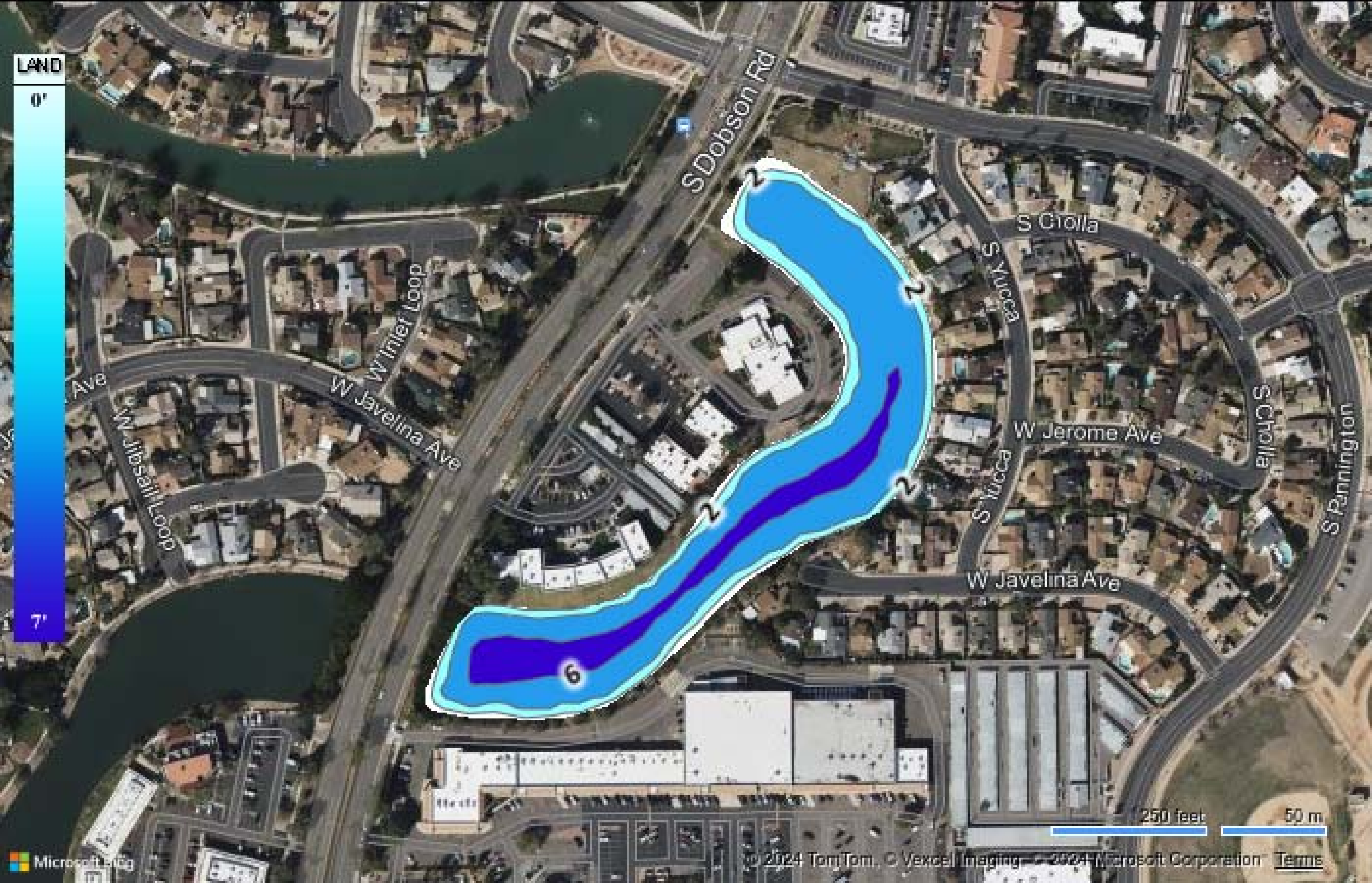

BIOBASE

Dobson Lake 3
3/19/2024

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Dobson Lake 3
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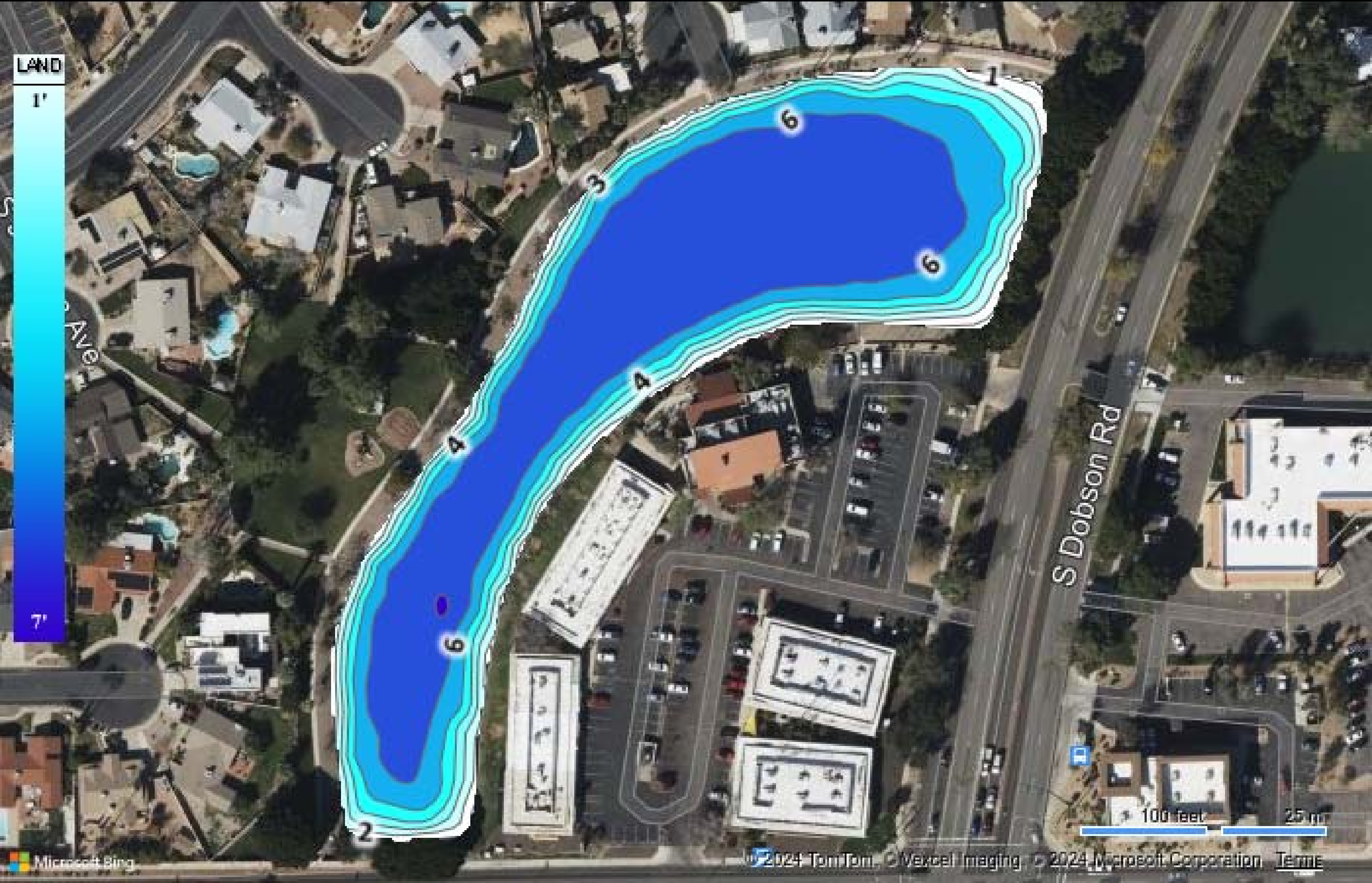

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Dobson Lake 5
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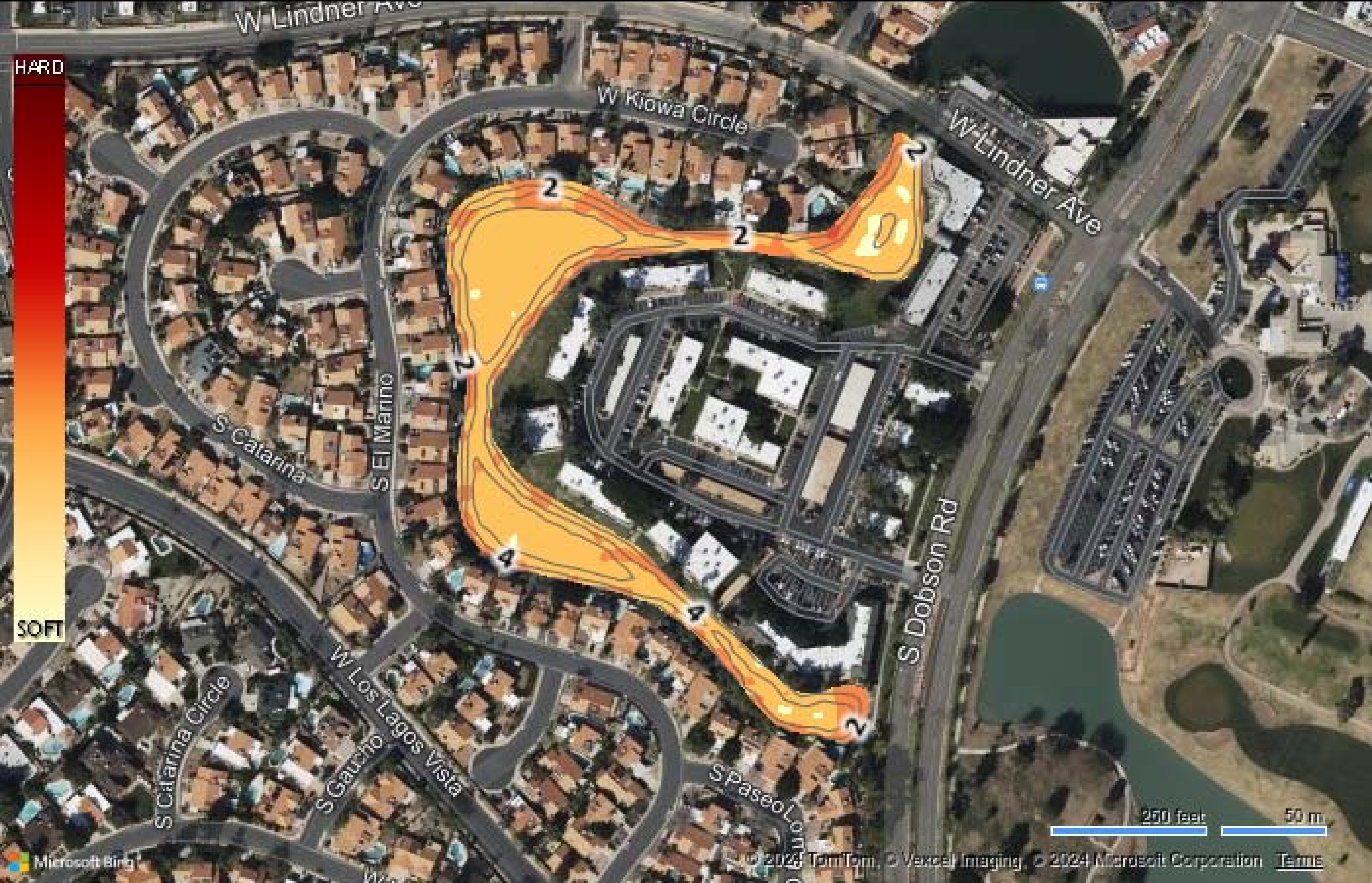

Dobson Lake 5

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Dobson Lake 4

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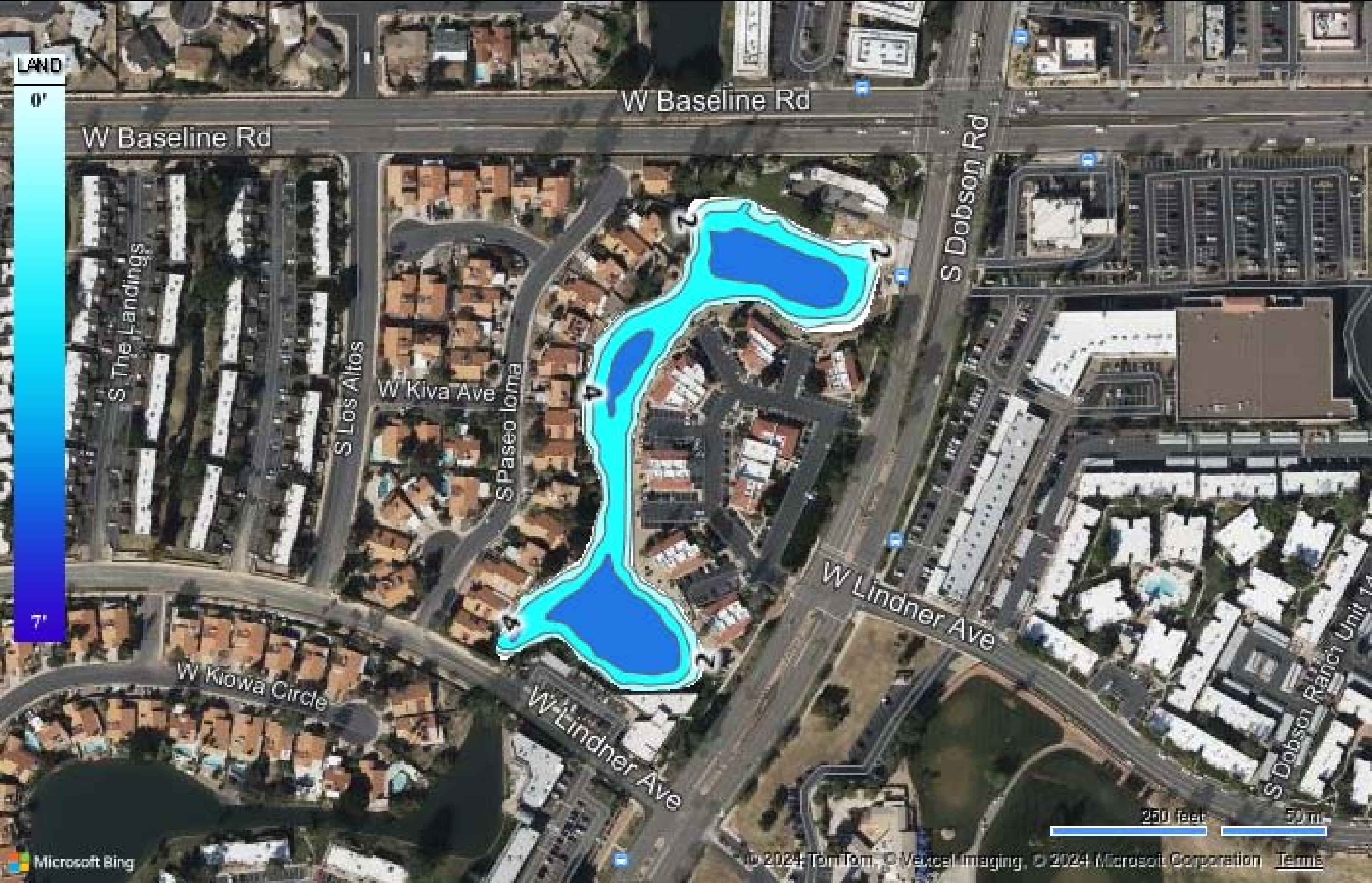

BIOBASE

Dobson Lake 7

3/21/2024

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