San Francisco Bay Conservation and Development Commission
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**TO**: All Financing the Future Working Group Members

**FROM:** Lawrence J. Goldzband, Executive Director (415/352-3653; larry.goldzband@bcdc.ca.gov)
Steve Goldbeck, Chief Deputy Director (415/352-3611; steve.goldbeck@bcdc.ca.gov)

**SUBJECT: Approved Meeting Summary of May 4, 2017 Financing the Future Working Group**

1. **Call to Order.** The meeting was called to order by Chair Wasserman at the Bay Area Metro Center, 375 Beale Street, Ohlone Room, First Floor, San Francisco, California, at 10:33 a.m.

2. **Roll Call.** Present were Group Members: Chair Zack Wasserman, Commissioners J.R. De La Rosa and Gibbs and Members: Mark Northcross, Michael Paparian, Paul Rosenstiel and Chad Spitler, Also present were: Mr. Bob Battalio, Executive Director Larry Goldzband, Chief Deputy Director Steve Goldbeck, Mr. Gary Griggs, Associate Professor Kristina Hill and Commissioners: Kate Sears and Jim McGrath.

**Not Present were Group Members:** Commissioners: Jennifer Lucchesi, Aaron Peskin, Dave Pine and Alex Zwissler and Members: James Cervantes, Justin Cooper and Roger Davis.

3. **Approval of the April 6, 2017 Meeting Summary**

**MOTION:** Member Mark Northcross moved approval of the minutes, seconded by Member Chad Spitler.

The motion passed with a voice vote of 6-0-1 with Member Paul Rosenstiel abstaining.

Attendees introduced themselves.

4. **Current Shoreline Projects and Funding Sources.** Kristina Hill, Associate Professor, University of California, Berkeley. Professor Hill addressed the Working Group and emphasized the following:

A number of points explaining the work that is being done by the Climate Readiness Institute were shared with the Group.

The first major item presented a comparison of adaptation strategies being implemented internationally including measures in Japan, the United Kingdom, the Netherlands and a discussion on the US Army Corps' CBR – cost benefit ratio rule.

Another important item discussed was, Inter-generational investment – transformability. Professor Hill stressed the importance of the relationship between the debt period and the functional life of a project.

Physical design for adaptation is a key concept and it needs to be incorporated into inter-generational finance.

A number of Bay Area cases were discussed as well. Currently eight cases are being looked at and discussed.

The South Bay Shoreline Study is a $140 million project with the Army Corps of Engineers. A special parcel tax was passed in Santa Clara County in 2012 that allowed this project to move forward as well as contributions from Santa Clara Valley Water District, the City of San Jose and a number of other jurisdictions. Groundwater is not addressed in this project even though it is a very important issue. The rising water table in the Bay Area is becoming a critical issue in many areas.

Executive Director Goldzband added that the presence of landfills around the Bay compounds this problem.

Professor Hill agreed and stated that many sites are contaminated with solvents as well as oil and gasoline and these can be re-mobilized causing problems.

The South Bay Salt Ponds project is a 30 million dollar project. It has received federal funding and is still looking for additional funds.

The San Francisquito Creek Project is a small project approximately 8,000 feet long between the Bay and Highway 101. It is a 43 million dollar project. It is intended to protect the community of East Palo Alto as well as the very expensive properties of Palo Alto.

They have begun to build walls which are an example of moving down a difficult path. Once you begin to put concrete and steel floodwalls on top of berms you are committing to a kind of L.A. River strategy of building walls and cutting off visual access and creating a brittle failure condition. If those walls fail it is a bad thing such as seen in New Orleans.

In this scenario the interaction between private development and FEMA flood zones is very important.

The Dutch have started building very expensive pond homes in areas continuously covered with water with floating foundations raised above the water level. This is something that we could consider here in the Bay Area.

The San Francisquito Project is an example of the public sector having taken on all the responsibilities of protecting the private sector. We should really question if this is a viable approach.

The Aramburu Island Project is just a habitat project. This 2.2 million dollar project was funded by the Cosco-Busan Oil Spill Fund. It has also received funds from a number of other agencies.

The big innovation is this project showed that we can build beaches that are relatively stable in places where there is a fair amount of wave action. This would make beaches part of our tool kit. Beaches need to be part of our tool kit and most of them are eroding.

When there is housing demand we need to think about how we can bring the private sector in to help us finance sustainable, resilient shoreline strategies for sea level rise.

We have some real constraints on particular strategies that can be implemented in different areas.

If you know the geography of the Bay then you know where you can the economy generate adaptation. You know where housing can be used to generate money for adaptation.

Different parts of the Bay are exposed to more wave energy because of the direction of the prevailing winds. The wind is mostly an East Bay phenomenon inside the Bay itself.

Wave energy would destroy wetlands if it is too high and wetlands do not pair well with waves.

The presence of a tributary is an unsolved problem because freshwater flooding in heavy rain events must be stored and/or discharged into the Bay at the same time saltwater is blocked from entering, fish passage must be allowed and mechanical tide gates have been shown to reduce inland aquatic habitat quality and increase deposition of sediment. A tide gate will only function for so long before it becomes a barrier; it has to be closed all the time. Sand gates are a potential alternative that requires testing. We are learning from Nature in thinking about how to build natural environments artificially as a way to allow tributary water to discharge but keep wave and wave energy from coming in.

The high groundwater table is a very significant problem. No one shows pumps in their proposed developments around the Bay Area. Whenever you put in levees you have to put in pumps because there is no other way to discharge the water from the landside; never mind the groundwater that is coming off and causing more flooding.

The expense and the in-perpetuity need for mechanical function of pumping is really under-estimated. And it will be very problematic as it has been in New Orleans.

Groundwater rising will infiltrate cracked pipes. Most of our pipes in the Bay Area are cracked. This means that sewage pipes may not be able to discharge to the sewage treatment plant because they are already full of water.

Mr. Bob Battalio mentioned that this was a major problem up and down the coast of California.

Professor Hill stated that there currently is no projected budget to line the cracked sewer pipes. Most of these pipes are set at between four and eight feet; groundwater will be rising as much as sea level rises within a kilometer or so of the Bay and this means that we will see the groundwater table rising by whatever sea level rises.

Executive Director Golzband opined that this rising of the groundwater table is another example of how communities that are not on the Bay are going to be affected by rising sea level.

Commissioner McGrath stated that the replacement rate for cracked pipes with East Bay MUD is less than one percent per year. There is definitely a ticking infrastructure time bomb here.

Ms. Kate Schaefer added that the other issue with rising groundwater is that we have one major liquid petroleum pipeline that runs around the Bay and it is subject to floating and that is of concern.

Professor Hill said that everything we put into the ground will have to be thought of more like New Orleans and the Delta as having a high water table and having to design structures to deal with it.

Thinking in terms of floating infrastructure may well be a viable idea for adaptation. This is also a good option in seismically-active areas because it takes the building out of the ground and allows it to deal with a shifting base.

The state of Washington has floating roadways in that it has a major, interstate, highway bridge that is built using this technology.

Path-dependency of infrastructure facilities addresses the concept of moving from centralized infrastructure to de-centralized strategies. There has to be some major changes in policy and investment cycles in order for this to happen. We need to think about when to make this call and how does this influence funding and investments?

Both our legacy, contaminated sites that are closed and buried and our current sites that use hazardous materials are all sources of risk.

It is clear that we have to put pressure on the private sector to build housing that is resilient rather than constantly building housing that is fragile to any amount of flooding. We need to think about ways to access these more robust and resilient urban districts; ways to get around in them, that may mean raising roadways, having canals and a whole different approach to connectivity.

The question of how private developers can play a role in this is very important. We need people who are willing to try some innovations. Maybe geologic hazard abatement districts are a way to go to allow some pilot projects. We have to bring in our real economy of the housing sector in order to generate funds to do the adaptation.

Mr. Battalio suggested that different areas around the Bay become more connected as sea level rises. Over time with higher sea levels a particular project may affect a larger and larger area so that the shore becomes more connected with climate change. One of the pathways is the future implications of actions with the changing environment.

Commissioner McGrath stated that the San Francisquito Project was very contentious in its permitting before the Regional Water Quality Control Board. There are endangered species upstream and in the surrounding marsh. The greatest difficulty was finding the political gravity among different political institutions to provide protection for a very different landscape in terms of economic levels and risk.

It is not a long-term solution. The regulatory system is poorly equipped to send it in a better direction. Trying to get all the different agencies involved together and talking with the same interests was virtually impossible.

One of the questions we should be thinking about is; at what point should we reflect about the cost of infrastructure protection as related to the risk and how do we make the political transition to the economic reality.

Professor Hill stated that we needed a development type that can be expanded as the magnitude of sea level rise goes up. This idea of pond urbanism, stormwater wet ponds – is adaptable to varying levels of sea level rise.

We need to start thinking about how we create pilots through public leadership preparing sites for innovations that could demonstrate our capacity to live with higher sea levels and flooding tributaries.

Member Northcross was particularly struck by the adaptation strategies on finance by other countries. He commented on the pros and cons of different strategies employed by different countries.

To get to inter-generational finance you need something that ties to the economy as a whole for multiple generations. The closest model we have is sales tax.

How the Army Corps defines damage is critical. Are you going to say that having water in various parts of San Mateo and Marin County on property that totals 50 billion dollars in assessed value is damaged or are they looking at just the value of the property?

This issue of how you define, “damage” is important because if we start looking at avoided costs assessed value is not market value, public infrastructure needs to be in there and damage is not value; they are different things.

Another burning layer that we don’t know how to deal with is where civil engineering turns into social work. I call these distributed systems. Instead of building one big, centralized facility you spread it all over like solar on rooftops.

In the public finance sector the truth is that we really are not very good financing distributed systems; we do centralized systems. That is what the whole model is built around. Distributed systems have a lot of issues is why I call it social work because you are having to get face-to-face. You have to get face time with thousands of people.

This is not what civil engineers or investment bankers do. The point that you are making is this may be the solution. To implement this is a huge change for how we do things. When we advocate a potential solution we need to acknowledge that we are turning 100 years of infrastructure development and finance into social work.

Professor Hill acknowledged this and observed that once a structure is in place; in a sense the market, as well as local government policies create these opportunities rather than investment bankers or civil engineers.

Member Rosenstiel stated that he agreed with Mark and disagreed with him at the same time. We've had a really hard time financing distributed systems. They are a necessity because I don't think we can raise money anymore for big projects. We can't get the political will for it. The politics of the East Bay MUD pipe replacements are awful because you are imposing rate increases on 100 percent of the people and only one percent are getting any benefit.

We're are going to move in this direction because people approve revenue increases when they know how the money is going to be used and that the money is going to be used for them.

The closer we can connect the imposition of some fee or tax to the benefit that is being provided the better the probability that the funds will be approved.

The state of California estimates that our current infrastructure has 70 billion dollars of unmet maintenance needs and this is a complete under-estimate. This number grows every year it does not decline.

It is going to get back top some kind of distributed approach.

This affects our infrastructure options too because the Dutch will give us advice based on what they would build. Our deferred maintenance culture really puts us in a limited choice situation.

Mr. Battalio added that it is real easy to get focused on where things are. What we haven't really talked about is moving things around. There is some development that may have to be relocated.

Member Paparian stated that there are a lot waste facilities around the Bay. There are three state agencies involved with these and that is DTSC, the Department of Toxic Substances Control, the Water Board and CalRecycle some of which have fee revenue which is covering the cleanup of these things.

I wonder if any of these state agencies would be intrigued by protecting their existing investments in cleanup of some of these dumps and whether they would want to prevent future problems associated with those. And then whether those funds that they have could be a source of some of the things that would be needed in the regions around those existing facilities. This might be a question worth asking and having a presentation from someone from one or all of those agencies.

There is an example of a distributed system and that is that government has gotten involved in the imposition of water meters on communities around California where the local governments have had to explain why this has to be done and explain what is going on. This is an example of how government has successfully dealt with distributed systems.

Professor Hill explained that the two percent of GDP used in Holland was based on the project needs rather than just a two percent target.

The Dutch are ahead of us in terms of flooding but we are all heading that way.

Kathy Schaefer stated that these issues of finance are also faced by New Zealand and Australia. They came up with a way of measuring the performance of infrastructure products much like we have the pavement management index. This concept originated in New Zealand and Australia. This is an alternative that communities can use to measure their performance. Virtually all communities chose not to do this because they were afraid it would affect their bond ratings.

Executive Director Goldzband found it interesting when Professor Hill started talking about decentralization. The way you get distributed measures implemented on a household-by-household basis is through the tax code because everybody has to pay taxes.

One of the things that this group may want to think about is not just financing in terms of the dollar side going in on big projects but the decentralized version of financing which could be done homeowner-by-homeowner through the tax code.

Professor Hill mentioned that most of our ways of thinking about building infrastructure in the hydrology world are driven by events. When the entire world experiences these phenomena at the same time; going to borrow as sea level is evidently rising is probably going to be a disadvantage in terms of the cost of borrowing.

It does seem to me that the only reasonable or strategic advantage that this region could achieve is to act early and to use the real economic engine of the market to create incentives for more floodable development. That is the only way that we can get ahead of the curve in terms of being ready for adaptation.

Chair Wasserman stated that we need to keep in mind as we discuss specifics that the end package in product is going to be an array of things. There is not one solution. The just-in-time approach will not work here and if it is employed we all just float away.

With many of these projects; they are experimental. We need to get some pilot projects out there as quickly as we can to get some sense of what happens.

5. **Rising Sea Level Projections: California Natural Resources Agency, Ocean Protection Council and Ocean Science Trust.** Commissioner DeLaRosa addressed the subject of the Sea Level Rise Guidance Document update. Professor Griggs will get more into the science synthesis which is the key component of what the guidance is going to be built around.

Commissioner DeLaRosa highlighted what the Sea Level Rise Document update was. He also talked about who was developing the document. Also addressed was who would be the intended users of the document. A discussion would also address when and where stakeholders can be involved in the public engagement process and the workshops.

The Sea Level Rise Guidance Document was first adopted in 2009 and then updated in 2013. We are now going through another update. It provides guidance to state agencies for incorporating sea level rise projections into their planning, investments, permitting actives as well as other activities.

The lead in updating this document is the Ocean Protection Council. The Natural Resources Agency is also working on this in collaboration with the Governor's Office of Planning and Research as well as the Ocean Science Trust.

The Ocean Science Trust has been charged with leading the scientific component of the update and convening the OPC Science Advisory Team Working Group which is comprised of subject-matter experts and has developed the science synthesis that Gary is going to be discussing.

The Guidance will focus on the needs of state agencies and it also incorporates the needs of local governments. It will help cities and counties comply with new laws that require them to incorporate climate adaptation into the safety elements of their general plan updates.

The update guidance is also going to assist state agencies as we prepare for and adapt to climate change as directed by Governor Brown's Executive Order B3015.

We were involved in an engagement process that led five listening sessions. This was done to better understand the needs of those that will be using this guidance. This month and next we are going to be having a series of public workshops with state, regional and local stakeholders to be soliciting feedback on how stakeholders can utilize the Guidance Document.

Professor Gary Griggs provided an introduction into the update. He emphasized that climate change and sea level rise have been going on for the four and a half billion years of Earth's history. What is new is that California has a shoreline that is developed and we didn't have this until 150 years ago.

The natural variations in climate have to do with how much energy we get from the sun which is tied into some irregularities in the Earth's rotation and distance to the sun which is a wobble, a tilt and an eccentricity which have periods of tens of thousands of years. Those are long-term changes not the things we are seeing over decades.

As climate changes, ice melts, water freezes, seawater expands and can cover hundreds of feet but over thousands of years. In the short term are things that we see here along the Embarcadero; we've got tides that change from five to ten feet daily, king tides which can add another two feet on top of that, storm surges along the coast – we can raise the level up to three feet over hours. El Nino can be a foot or two over months and then wave run up and wave set up during big events. These are short term and much, much larger than a couple of millimeters per year.

And then there are geographic differences. There is a global sea level or an absolute which is how much water is in the oceans. Then there is relative or regional or local sea level which depends on what the land is doing. There are also gravitational effects of things like Antarctic and ice.

The 2010 Natural Resource Council on Sea Level Rise Study points out that over the last century the general consensus was that thermal expansion made up most of the bulk of sea level rise and continental glaciers made up much of the rest.

When we finished our report we felt that ice melt was becoming the bigger factor. And that's what we have to worry about in the future.

As Earth has warmed and cooled we have gone into glacial cycles, inter-glacial cycles and sea level has risen and fallen. This is over the last 350,000 years of sea level rise.

At the peak of the last Ice Age about three percent of all the water in the oceans was converted to ice and we lowered sea level about 400 feet.

Virtually any other time during the last 350,000 years sea level would have been someplace else. If we look at the last 20,000 years sea level was 390 to 400 feet lower and from about 18,000 years ago to about 8,000 years ago it rose pretty quickly.

About 8,000 years ago sea level rise slowed to maybe less than a millimeter a year.

Today we see a rise of roughly 3.3 millimeters per year which is equivalent to two quarter or 13 inches per 100 years. In all likelihood this rise is going to increase. This may be the biggest challenge civilization has ever had to face.

With 150 million people living today living within three feet of high tide and eight of the world's largest cities on coasts; we built cities without regard to sea level rise which wasn't an issue 100 years ago.

The San Francisco Tide Gauge is the oldest in North America and you can see that it is rising over the last century pretty close to the global average; 1.94 millimeters per year or 7.5 inches per 100 years.

All those global numbers for sea level in the last century were based on global averages from tide gauges. We realized that most of them were in North America and Europe and very few in Africa and Asia.

The information we have received thus far from satellite surveillance spells out the importance of long-term monitoring and there are some threats right now to the budgets for long-term monitoring of global temperatures or sea level. There is some uncertainty; what's going to happen next and the biggest uncertainties are the ice on the planet.

If we melt all of the continental glaciers it is about a foot and a half of sea level rise. This is not a big concern unless you are within a foot and a half of sea level.

Greenland has about 24 feet of sea level rise equivalent if we melted all of Greenland. Antarctica has about 190 feet of sea level rise. If that happens we are toast here.

So roughly the two combined equals roughly 216 feet of sea level rise. Nobody thinks this is going to happen but you don't have to melt all of that to create serious problems.

In our study of 2010 we determined that from 1800 to 1900 most of our sea level numbers are based on geological evidence; we didn't have tide gauges. It did not look like a lot of change.

From the late 1800s to 1993 relying on tide gauges and satellites that nearly doubled. We have been using models and they can tell us something about what the most important factors are and this begins to tell us where we should be putting our effort.

One of the parameters of our study was to project sea level rise at 2030, 2050 and 2100. The further out we go the greater is the uncertainty because the unknowns get greater. These unknowns include scientific as well as social and political unknowns.

We looked at what was happening in Antarctica and it is the biggest source of water for the oceans and we put some physics into it which had not been done in earlier work.

Antarctica holds 61 percent of the Earth's freshwater. This is six and a half million cubic miles. If that melts that could raise sea level a total of roughly 190 feet.

The key findings of the study were that sea level rise is advancing quickly, the direction is clear and Antarctica and Greenland are the big sources and those rates are increasing. Evidence now exists that sea level rise could reach some extremes and we tried to report on the probabilities of different scenarios.

We then looked at how this might help us with policy decisions for the future. To wait until we know for certain is not a good approach.

The Arctic and Antarctic atmospheres are warming much faster than mid latitudes. This is starting to create cracks, fractures and fissures and melt water is flowing down through the ice shelf. This tends to make the ice shelf unstable. Ice sheet instability is caused in part from melting from below the shelf by a warming ocean.

One of the things that was important was the different greenhouse gas emission scenarios. We used a watt per square meter of heat that is accumulating measure.

The best scenario is a 2.6 based on the Paris Agreement and we cut back on everything rapidly. There then some intermediate ones and then 8.5 is business as usual where we just keep going the way we are going. Up until 2050 there will not be a big difference. After 2050 climate change starts happening much more rapidly.

We also produced an H++ extreme scenario that is possible but we could not put a probability on it. It is possible but not likely.

By 2100 we used a three foot rise in sea level which is what most agencies are using. This report looked at the ranges and probabilities of other values and also brought in the greenhouse gas scenarios.

Professor Hill observed that the numbers being discussed were based on modeling and not historical data and as our models change the probabilities will change.

We are dealing with uncertainties. One of them is model uncertainty; how good are the models based on what we know exists right now and they are not based on historical data.

What is the future of greenhouse gas emission scenarios? Those change considerably as time goes by. There are natural variations in the Earth's climate but clearly the things we are seeing today aren't a reflection of sun spots, volcanic eruptions and these Earth orbital cycles.

As natural or human cycles warm the Earth ice reflects a lot of sunlight, open water absorbs it. As the water gets warmer in the ocean it gives off more CO2 and permafrost also emits CO2 as it warms and starts to thaw. Natural cycles could bring that back but we are not going in that direction.

Member Paparian spoke with folks that have been working in Antarctica and there are things that they have been able to publish and there are things that worry them. What worries them is whether we have gotten into some sort of feedback loop that is irreversible for some of the areas of Antarctica. Do you have any thoughts on this?

Professor Griggs said that most climate scientists would say that we have baked a lot into the system. It is really hard to say how long CO2 lasts in the atmosphere because there are a lot of different things that can happen to it. What we have put into the atmosphere so far is going to stay there for 100 to 200 years.

No matter what we do in California roughly 85 percent of our energy is from fossil fuels and in the U.S. and globally. To turn that around quickly is going to be challenging. The tipping points are still an uncertainty. The good thing and the bad thing is that it is still happening slow enough but it is not something that gets everybody's attention.

So a big question is, how much do you invest in something that is a generation away? This is a slow, creeping hazard and we in California are way out in front and BCDC has been out in front for many years on this.

The challenges are; depending on what we are thinking about as the infrastructure of the project that we need to know a number for – it seems like there are some huge differences between what does it cost and how long will its lifespan be and what happens if we lose it? When I think of extremes I think of SFO; that's probably something we are going to want to protect along with Oakland for quite a while. Airport expansion and build outs need to take sea level rise into account to determine if any development is warranted and sustainable.

Member Northcross inquired about potential numbers for Bay level rise and what levels should be used for planning. He asked Professor Griggs to pick a number for 2050 and 2100.

Professor Griggs it has to do in large part on what we are planning on. If it's a wetland and a marsh boundary, that's one thing; but if it's another big zillion dollar skyscraper then I would be more cautious. I think the three to four foot range for 2100 is right in the range that seems to fit almost all those studies. What we say is that we should be re-assessing this every five years because the science is advancing so rapidly. We want to keep watching the situation to see what the satellites tell us is happening. This is a moving science.

Mr. Battalio mentioned that the Design and Criteria Review Board is indicating to applicants that accommodation of a three foot sea level rise is a reasonable amount and then we ask for adaptive capacity beyond that and how they would adapt and how they could build in the capacity to adapt.

Professor Griggs stated that 18 inches to two feet would be a reasonable number to use for 2050.

Member Rosenstiel stated that 35 to 85 years are the periods of time during which we would recycle or renew our infrastructure and this is an important thing because some people would not want to worry about sea level rise or do not believe it is going to happen. The concept of integrating sea level rise into what we normally do in terms of renewing our infrastructure might help a lot in getting to a politically feasible financing situation.

Professor Griggs stated that this was a very important point. He saw a similar analogy with dams that are now not letting fish pass and full of sediment. They are also no longer safe seismically. That infrastructure half-life is a critical point that may override and deal with some of the more emotional issues.

Commissioner McGrath observed that the amount of heat stored in the ocean was not mentioned by Professor Griggs. Is there a way to talk about this? We don't know how fast it is coming out of the oceans but it is a big number and worrisome.

Professor Griggs likened it to a water heater analogy. You fill your water heater to a certain level and you leave a certain amount of room for expansion or you will blow up your heater. The oceans are doing that same thing. As you heat them up they expand. We figured out that the deep oceans are getting warmer slowly as well. We did not deal with that in this report in any great detail because the big focus was on what is happening with the ice. Thermal expansion was the big player in the 1900s versus today where the ice is going to overtake it. The ocean is a huge reservoir to keep warming up.

6. **A Discussion of Future Meeting Topics and Schedules.** Executive Director Goldzband announced that for the next meeting a discussion of geologic hazard assessment districts would be in order. The subject of green bonds would also be apropos for a future meeting.

Chair Wasserman added that another good subject would be the flood control districts.

A discussion was had around potential meeting dates in June and July. It was announced that the next meeting would be Thursday, June 1st and that possible dates for July would be discussed with Members via emails.

7. **Adjournment.** There being no further business, Chair Wasserman adjourned the meeting at 12:26 p.m.

Respectfully submitted,

ANDREA GAFFNEY
Bay Design Analyst

Approved, with no corrections at the
Financing the Future Working Group Meeting of June 1, 2017.