Oceano Community Services District

1655 Front Street, P.O. Box 599, Oceano, CA 93475

(805) 481-6730 FAX (805) 481-6836

Date: **December 12, 2018**

To: Board of Directors

From: Carey Casciola, Business and Accounting Manager

Subject: **Agenda Item #8(C): Recommendation to Approve Cash Disbursements - REVISED**

Recommendation

It is recommended that your Board approve the attached cash disbursements.

Discussion

The following is a summary of the attached cash disbursements:

Description	Check Sequence*	Amounts
	57382 – 57429 & 57436	
Disbursements Requiring Board Approval prior to Payment:		
Regular Payable Register – paid 12/12/2018	57396 - 57420	$71,146.52
Added Warrants Register – paid 12/12/2018	57421 - 57429	$7,008.93
Added Warrants Register – paid 12/12/2018	57436	$254.62
REVISED Subtotal:		$78,410.07
Reoccurring Payments for Board Review (authorized by Resolution 2016-07):		
Payroll Disbursements – PPE 11/24/2018	N/A	$30,310.46
Reoccurring Utility Disbursements – paid 11/24/2018	57388 - 57393	10,826.68
Reoccurring Health/Benefits – paid 11/30/2018	57394 - 57395	$6,927.14
Subtotal:		$48,064.28
REVISED Grand Total:		**$126,474.35**

**Checks 57382 – 57387 VOIDED due to a printing error.*

**Check 57428 VOIDED due to total error and was replaced with Check 57436 for $254.62 to Quill for office supplies.*

Other Agency Involvement: n/a

Other Financial Considerations: Amounts are within the authorized Fund level budgets.

Results

The Board's review of cash disbursements is an integral component of the District's system of internal controls and promotes a well governed community.

COMPANY: 99 - POOLED CASH FUND
ACCOUNT: 1-1001-000 POOLED CASH OPERATING
TYPE: All
STATUS: All
FOLIO: All

CHECK DATE: 0/00/0000 THRU 99/99/9999
CLEAR DATE: 0/00/0000 THRU 99/99/9999
STATEMENT: 0/00/0000 THRU 99/99/9999
VOIDED DATE: 0/00/0000 THRU 99/99/9999
AMOUNT: 0.00 THRU 999,999,999.99
CHECK NUMBER: 057421 THRU 057429

ACCOUNT	--DATE--	--TYPE--	NUMBER	---------DESCRIPTION----------	----AMOUNT---	STATUS	FOLIO	CLEAR DATE
CHECK:								
1-1001-000	12/12/2018	CHECK	057421	AUTOSYS, INC.	2,025.00CR	OUTSTND	A	0/00/0000
1-1001-000	12/12/2018	CHECK	057422	PERRY'S ELECTRIC MOTORS & CONT	206.25CR	OUTSTND	A	0/00/0000
1-1001-000	12/12/2018	CHECK	057423	BURDINE PRINTING & GRAPHICS	49.81CR	OUTSTND	A	0/00/0000
1-1001-000	12/12/2018	CHECK	057424	GSI WATER SOLUTIONS, INC.	1,503.57CR	OUTSTND	A	0/00/0000
1-1001-000	12/12/2018	CHECK	057425	CLINICAL LAB OF SAN BERNARDINO	550.00CR	OUTSTND	A	0/00/0000
1-1001-000	12/12/2018	CHECK	057426	RABOBANK VISA CARD	650.34CR	OUTSTND	A	0/00/0000
1-1001-000	12/12/2018	CHECK	057427	MINER'S ACE HARDWARE, INC.	23.96CR	OUTSTND	A	0/00/0000
1-1001-000	12/12/2018	CHECK	057428	QUILL CORPORATION VOIDED	2,254.62CR	VOIDED	A	12/12/2018
1-1001-000	12/12/2018	CHECK	057429	MOSS, LEVY & HARTZHEIM	2,000.00CR	OUTSTND	A	0/00/0000
MISCELLANEOUS:								
1-1001-000	12/12/2018	MISC.	057428	QUILL CORPORATION VOIDED	2,254.62	VOIDED	A	12/12/2018

TOTALS FOR ACCOUNT 1-1001-0	CHECK TOTAL:	9,263.55CR
	DEPOSIT TOTAL:	0.00
	INTEREST TOTAL:	0.00
	MISCELLANEOUS TOTAL:	2,254.62
	SERVICE CHARGE TOTAL:	0.00
	EFT TOTAL:	0.00
	BANK-DRAFT TOTAL:	0.00
TOTALS FOR POOLED CASH FUND	CHECK TOTAL:	9,263.55CR
	DEPOSIT TOTAL:	0.00
	INTEREST TOTAL:	0.00
	MISCELLANEOUS TOTAL:	2,254.62
	SERVICE CHARGE TOTAL:	0.00
	EFT TOTAL:	0.00
	BANK-DRAFT TOTAL:	0.00

From: Susan Thomas
To: Celia Ruiz
Subject: Re: Vacation Time Off
Date: Wednesday, December 12, 2018 3:58:20 PM

I spoke with Casey and he informed me that the membership was happy with it. So it sounds like a go!

Merry Christmas!

Susan Thomas
Local 620

Sent from Yahoo Mail for iPhone

On Wednesday, December 12, 2018, 3:54 PM, Celia Ruiz <celia@oceanocsd.org> wrote:

From: Celia Ruiz <celia@oceanocsd.org>
Sent: Tuesday, December 11, 2018 12:31 PM
To: 'susan@seiulocal620.org' <susan@seiulocal620.org>
Subject: Vacation Time Off

Susan,

I am write to inform you that Union members would like to take 12/24 and 12/31 as 4 hrs. off vacation. I will also like to take it off as vacation.

We just need a response back that you guys are ok with that to submit to the Board for approval.

Thank you

Celia Ruiz

Account Administrator III

Oceano Community Services District

1655 Front St., PO Box 599

Oceano, CA. 93475

Office (805) 481-6730

Fax (805) 481-6836

http://oceanocsd.org/main/

Celia Ruiz

From: Nicole Miller <nicole@oceanocsd.org>
Sent: Friday, December 07, 2018 12:41 PM
To: 'Celia Ruiz'
Subject: Vacation Time for Dec

Hello,
I agree to using 4 hours of vacation for 12/24 and 4 hours of vacation for 12/31.

Thank you,
Nicole

Nicole Miller
Account Administrator III
Oceano Community Services District
1655 Front St. | PO Box 599 | Oceano, CA 93475
Main (805) 481-6730 | Fax (805) 481-6836
www.OceanoCSD.org

Celia Ruiz

From: jason@oceanocsd.org
Sent: Monday, December 10, 2018 8:49 AM
To: Celia Ruiz
Subject: No Subject

im taking 4 hours of vacation on December 24th and December 31st

Celia Ruiz

From: Casey Stewart <casey@oceanocsd.org>
Sent: Monday, December 10, 2018 3:29 PM
To: celia@oceanocsd.org

I'm cool with the 4 hours the 24th and 31st
Sent from my Verizon Smartphone

Celia Ruiz

From: Tony Marraccino <tony@oceanocsd.org>
Sent: Monday, December 10, 2018 3:35 PM
To: Celia Ruiz
Subject: time off

i am good to take off Dec 24 and Dec 31 with vacation

Tony Marraccino
Utility Systems Supervisor
805-574-4860 Oceano C.S.D.

Paavo

From: Celia Ruiz [celia@oceanocsd.org]
Sent: Tuesday, December 11, 2018 10:37 AM
To: 'Art Vega'
Cc: paavo@oceanocsd.org
Subject: RE: Board Meeting

Good morning,

I will forward the message to Paavo.

Thank you

Celia Ruiz
Account Administrator III

Oceano Community Services District
1655 Front St., PO Box 599
Oceano, CA. 93475
Office (805) 481-6730
Fax (805) 481-6836

http://oceanocsd.org/main/

From: Art Vega <artvega51@gmail.com>
Sent: Tuesday, December 11, 2018 9:00 AM
To: Celia Ruiz <celia@oceanocsd.org>
Subject: Re: Board Meeting

Good morning Celia
We would like to postpone the appeal until the 1st board meeting of the year so we have more time to prepare. Let me know if this is a problem or if we need to submit another request.
Thank you,
Art Vega

On Mon, Dec 10, 2018 at 8:50 AM Celia Ruiz <celia@oceanocsd.org> wrote:

Art,

I have attached the Agenda and the Intent to serve appeal for your review. Let us know if you want to meet and discuss before the meeting on Wednesday.

Thank you

Celia Ruiz

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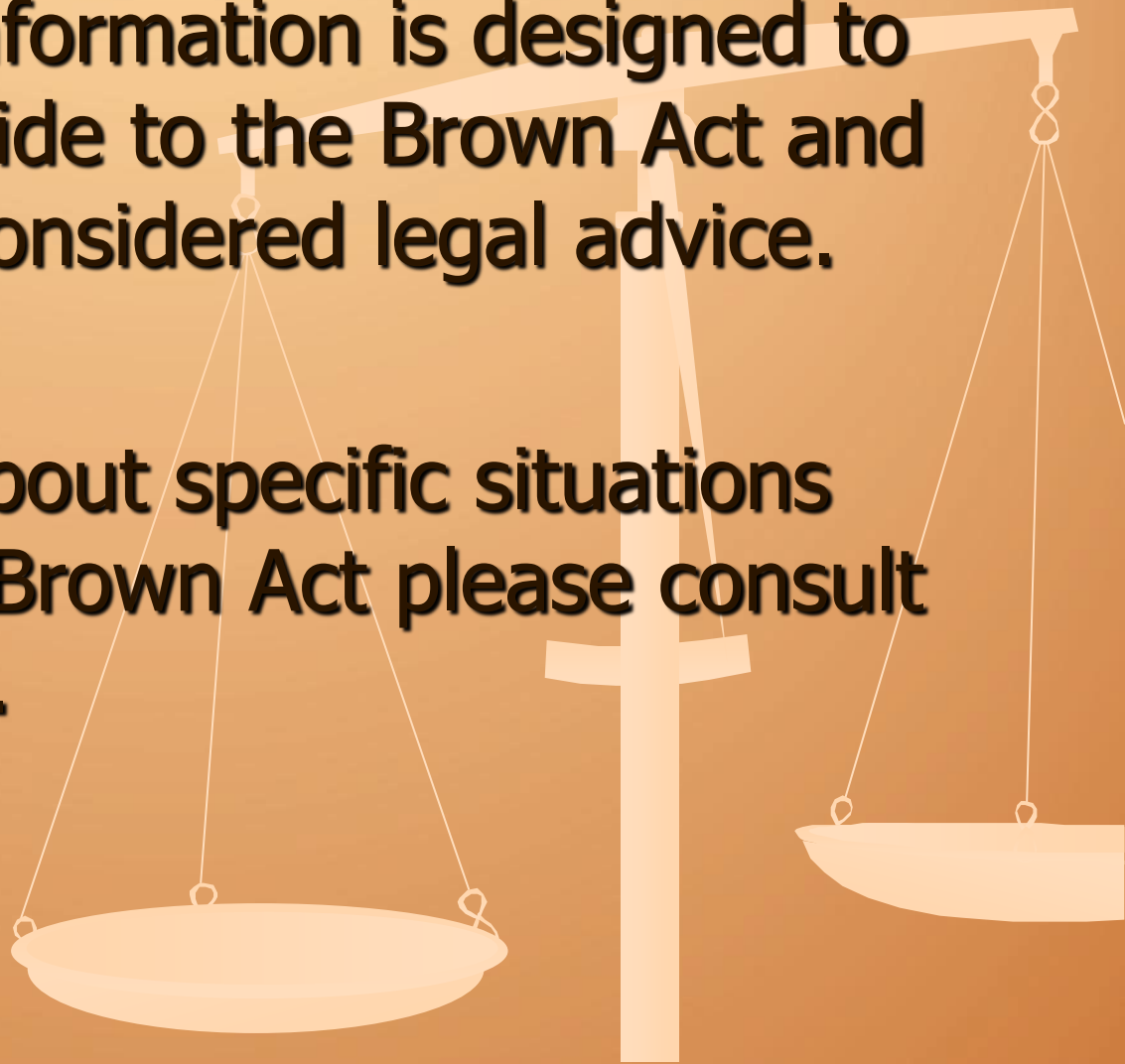
http://oceanocsd.org/main/

Understanding the Ralph M. Brown Act

Disclaimer

The following information is designed to be a general guide to the Brown Act and should not be considered legal advice.

For questions about specific situations concerning the Brown Act please consult District Counsel.



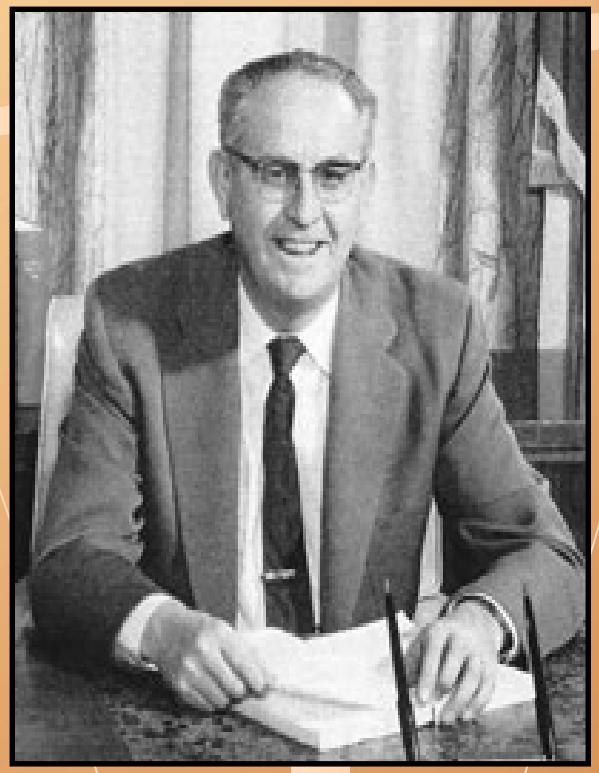
Purpose of the Brown Act

- To guarantee the public's right to attend and participate in meetings of local legislative bodies.

Open and Public

"The people, in delegating authority, do not give their public servants the right to decide what is good for the people to know and what is not good for them to know."

-California Government Code §54950



Ralph M. Brown 1959

Photo courtesy The Modesto Bee

PRESENTATION OVERVIEW

I. BODIES COVERED

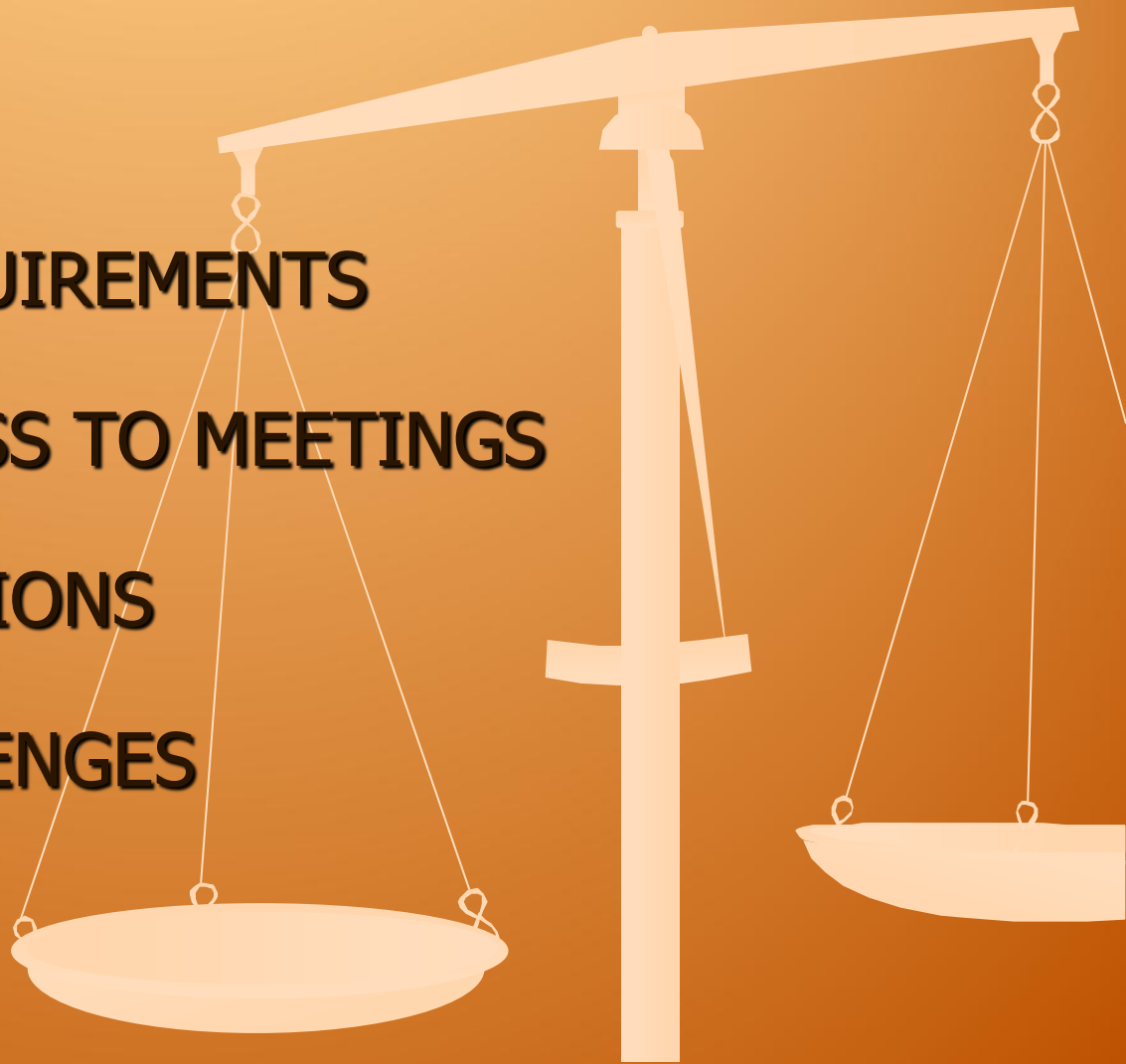
II. MEETINGS

III. AGENDA REQUIREMENTS

IV. PUBLIC ACCESS TO MEETINGS

V. CLOSED SESSIONS

VI. LEGAL CHALLENGES



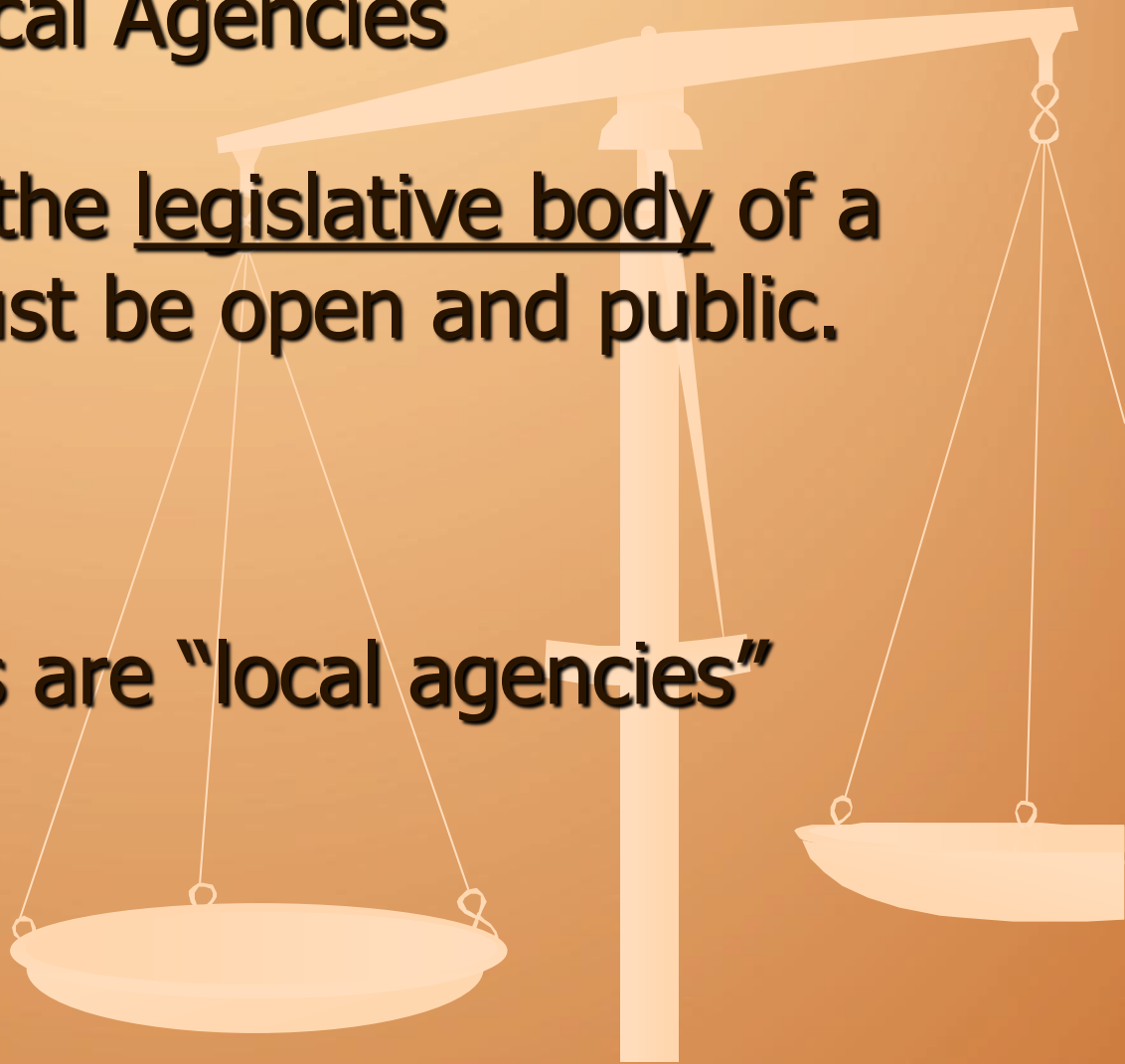
I. BODIES COVERED

Local Agencies

- All meetings of the legislative body of a local agency must be open and public.

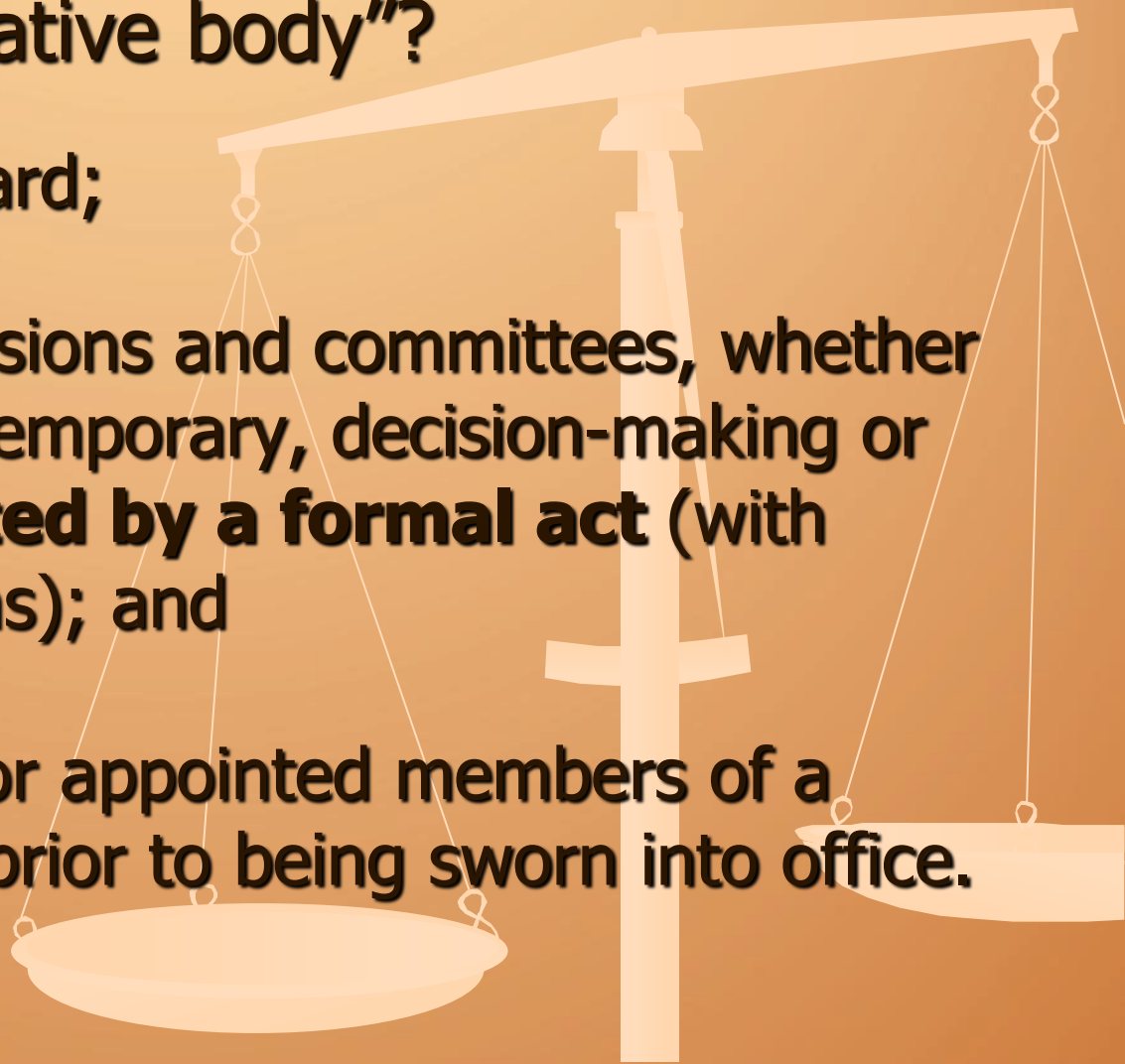
  §§54951-54952

-- Special Districts are "local agencies"



Regulated Legislative Bodies

- What is a "legislative body"?
  - The District Board;
  - District commissions and committees, whether permanent or temporary, decision-making or advisory, **created by a formal act** (with some exceptions); and
  - Newly elected or appointed members of a covered body, prior to being sworn into office.



Ad-Hoc Advisory Committee Exception

- The Brown Act does not apply to:

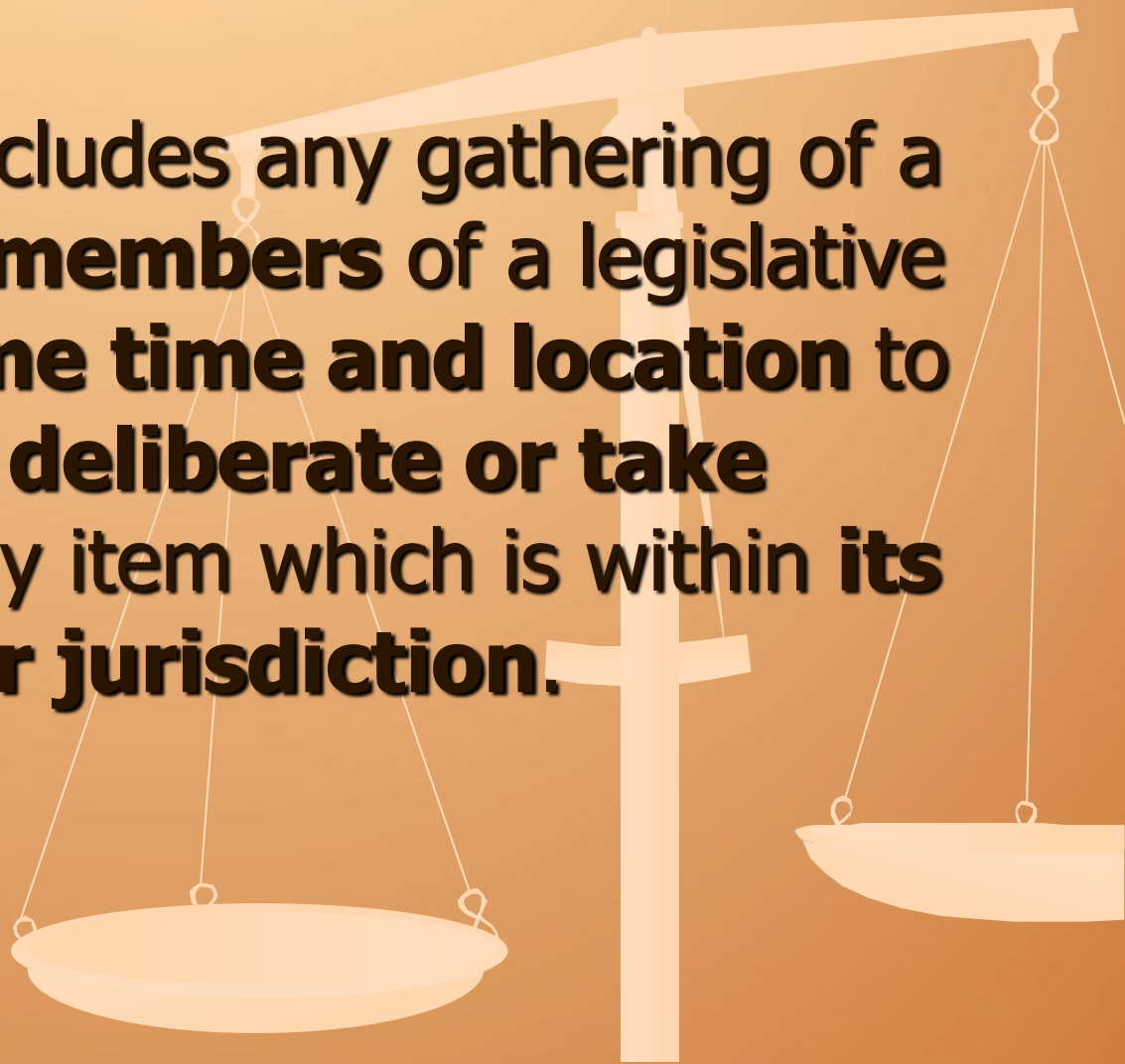
-- Ad-hoc advisory committees composed solely of less than a quorum of the board members **unless**:

  - It is a **standing committee** that has continuing subject matter jurisdiction; **or**

  - It has a **meeting schedule fixed** by formal action of the board.

II. MEETINGS

- A "**meeting**" includes any gathering of a majority of the **members** of a legislative body at the **same time and location** to **hear, discuss, deliberate or take action** upon any item which is within **its subject matter jurisdiction**.



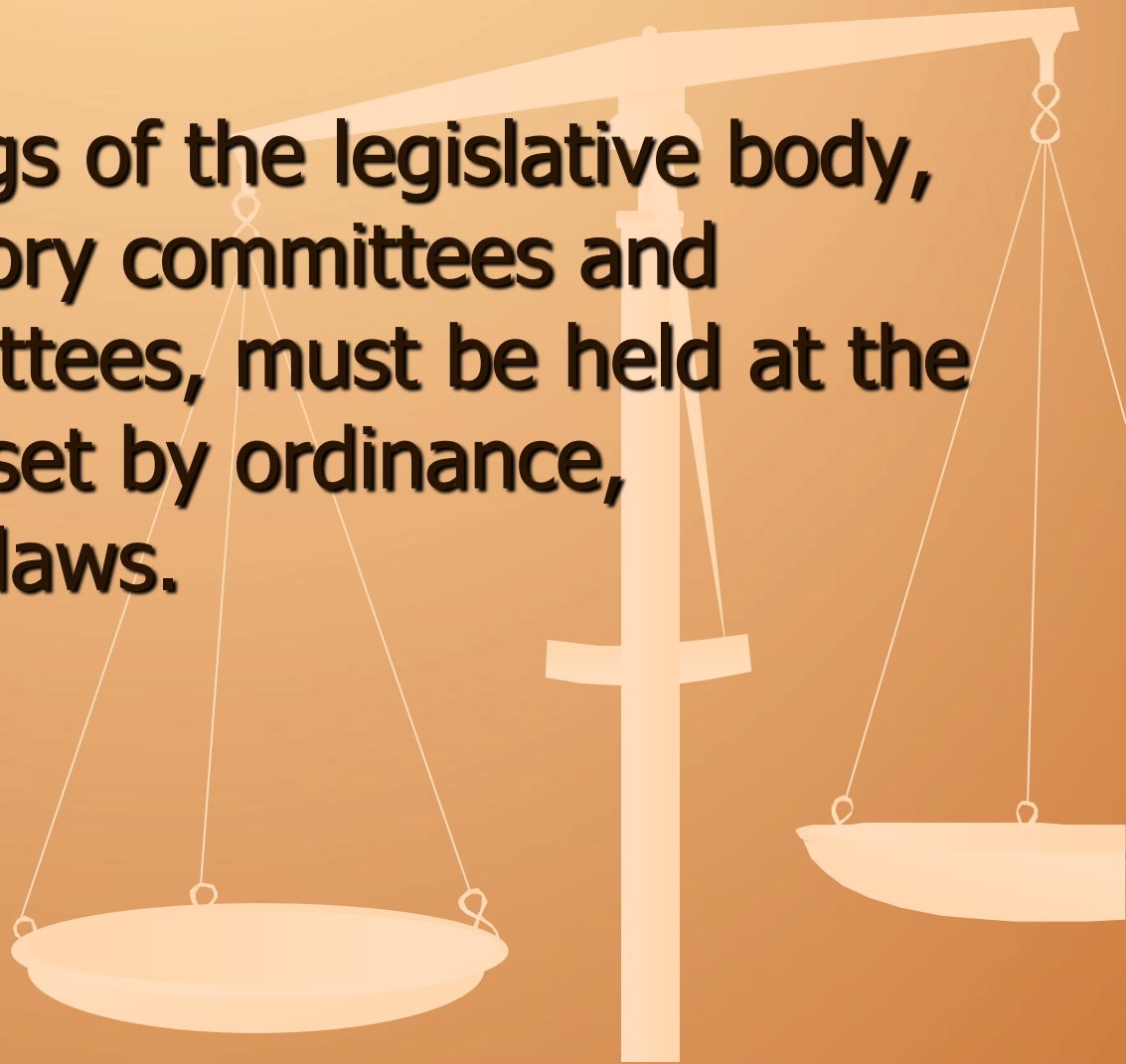
Types of Meetings

- **Formal Meetings**
  - Regular meetings
  - Special meetings
  - Emergency meetings
  - Teleconference meetings
- **Informal Meetings**
  - Daisy Chain
  - Hub and Spoke
  - Email/Technology

Regular Meetings

- Regular meetings of the legislative body, excluding advisory committees and standing committees, must be held at the time and place set by ordinance, resolution or bylaws.

§ 54954(a)



Special Meetings

- The presiding officer or a majority of the legislative body may call a special meeting at any time.
- Written notice must be delivered at least 24 hours before the time of the meeting to each legislative body member (unless waived in writing), to each local newspaper of general circulation, radio and TV station which has requested such notice in writing, and posted on the agency's website.
- Only the business set forth in the notice may be considered in the meeting.

§ 54956

Emergency Meetings

The legislative body determines a work stoppage, crippling disaster, or other activity severely impairs public health or safety.

The legislative body determines that a "dire" emergency exists, such as mass destruction, terrorist act or threat *that poses immediate and significant peril.*

The special meeting provisions apply to emergency meetings, except one-hour telephone notice may be provided.

§ 54956.5 (a) and (d)

Teleconference

- Meetings may be conducted by teleconferencing (i.e., any electronic audio or video connection) under the following conditions:
  - Agendas must be posted at video teleconferencing locations specifying all teleconference locations;
  - There is public access to teleconference locations;
  - There is public opportunity to speak at each teleconference location; and
  - All votes are taken by roll call.

Off-Site Meetings

A meeting may be held off-site in limited circumstances, such as:

- Inspect real or personal property that cannot be conveniently brought to the agency.
- Participate in a multi-agency meeting (if that meeting takes place within the jurisdiction of one of the members of the multi-agency).
- In an emergency, for reasons of safety.

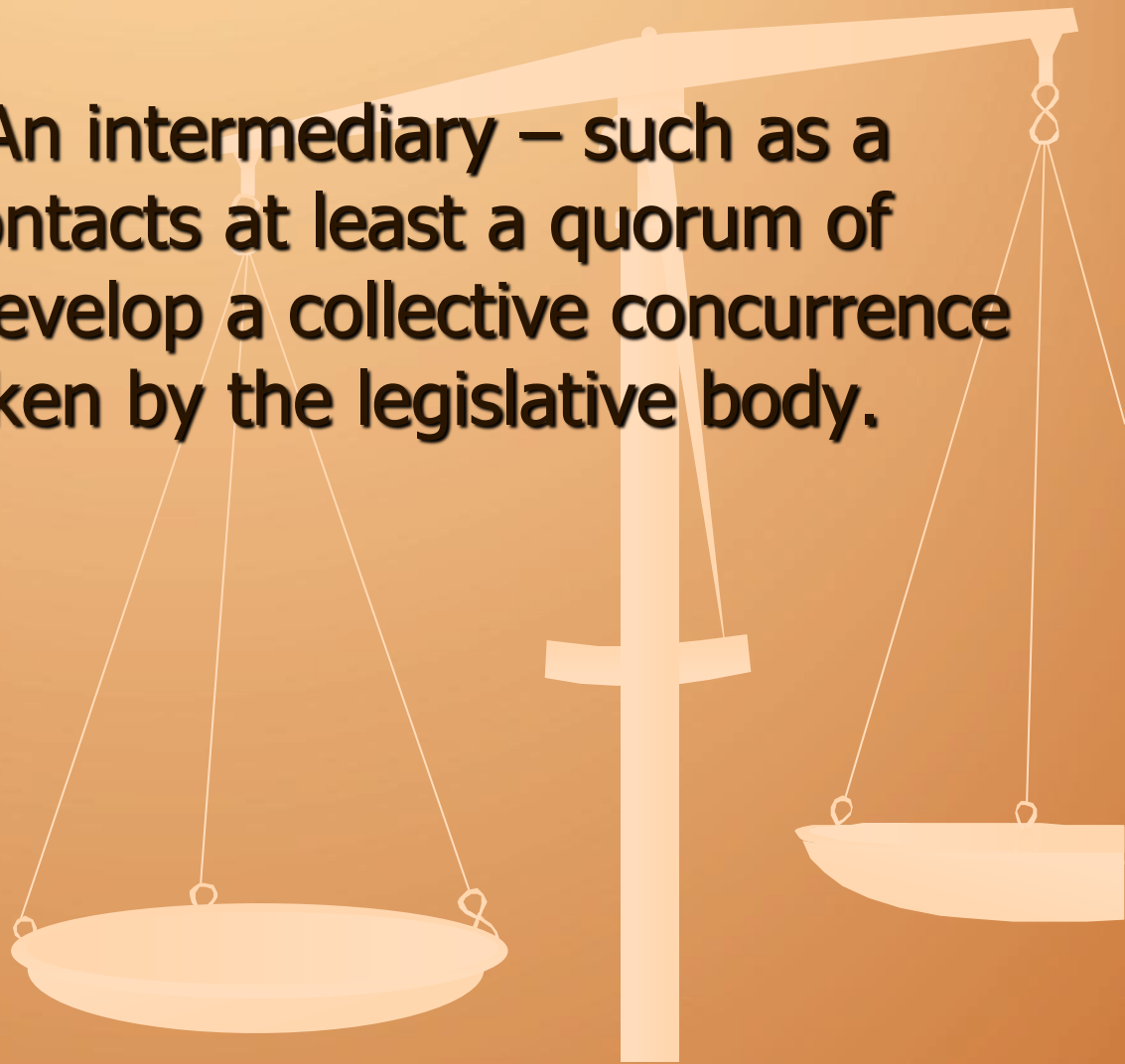
§ 54954 (b) and (e)

Serial Meetings

- Daisy Chain: If Member A contacts Member B, and Member B contacts Member C, and so on, until a quorum has been involved, this type of "serial meeting" may result in a violation of the Brown Act.

Serial Meeting

- Hub and Spoke: An intermediary – such as a staff member – contacts at least a quorum of the members to develop a collective concurrence on action to be taken by the legislative body.

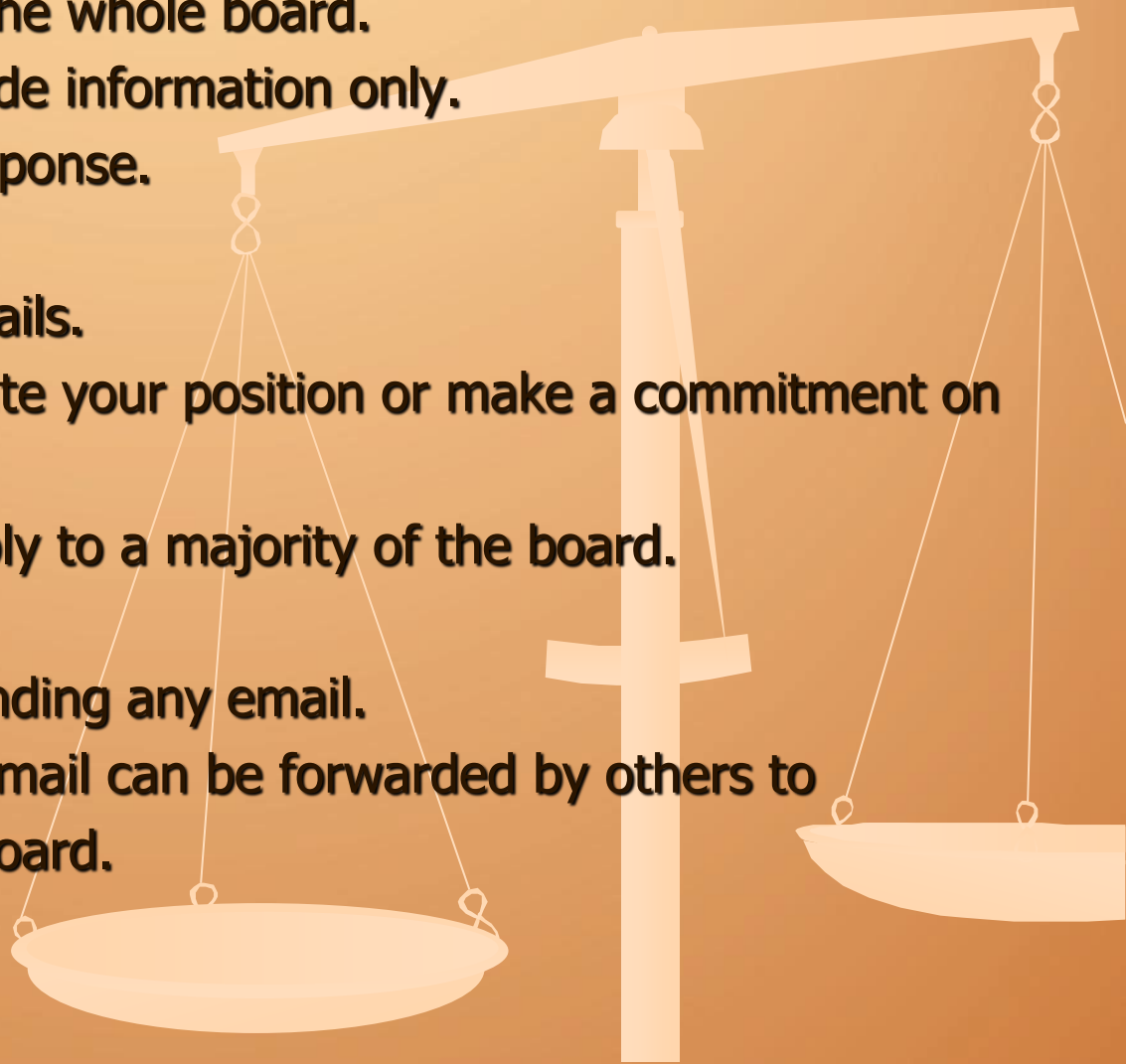


Concerns with Email

- Avoid sending emails to the whole board.
  - If necessary, provide information only.
  - Do not solicit a response.

- Be careful replying to emails.
  - Do not communicate your position or make a commitment on a pending matter.
  - Do not direct a reply to a majority of the board.

- Think carefully before sending any email.
  - Remember, your email can be forwarded by others to a majority of the board.



Not a Meeting

- An employee or official of a local agency may engage in **"separate conversations or communications"** outside of a meeting in order to **"answer questions or provide information"** so long as that person **"does not communicate to members of the legislative body the comments or positions of any other member or members."**

§ 54952.2(b)(2)

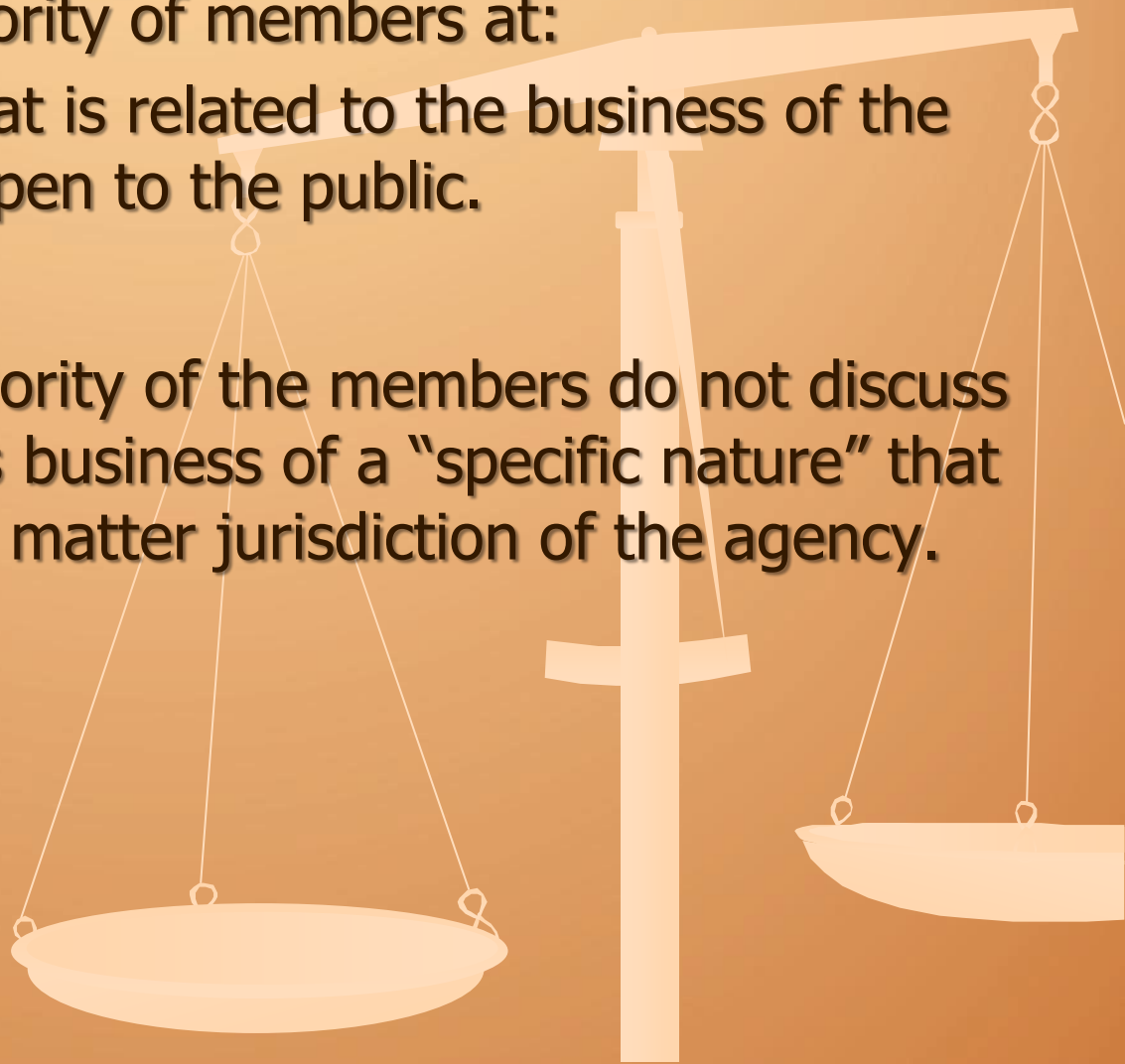
Not a Meeting

- Attendance by a majority of members at:

  -A conference that is related to the business of the agency that is open to the public.

Provided that a majority of the members do not discuss amongst themselves business of a "specific nature" that is within the subject matter jurisdiction of the agency.

§54952.2(c)(2)

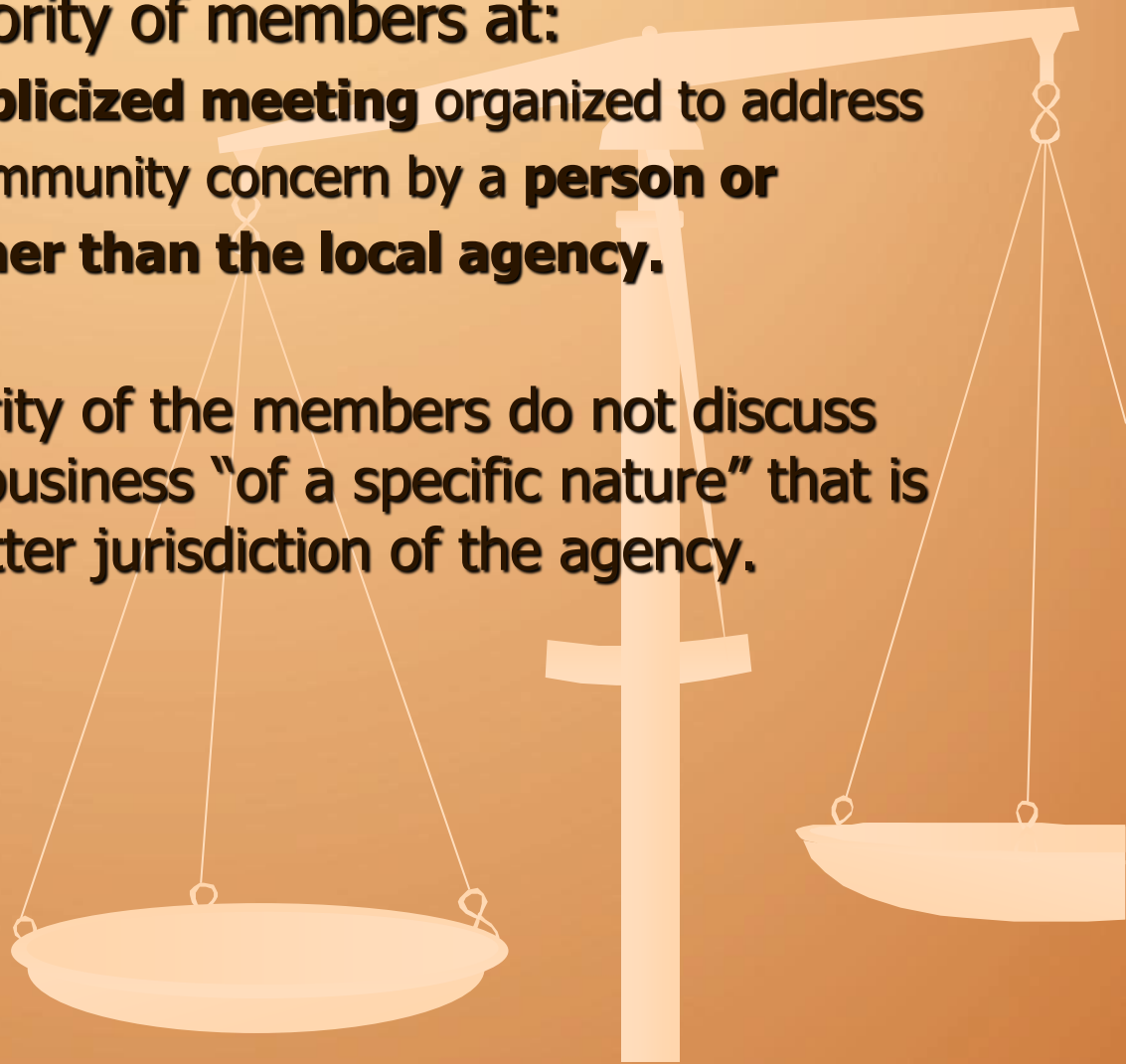


Not a Meeting

- Attendance by a majority of members at:
  - An **open and publicized meeting** organized to address a topic of local community concern by a **person or organization other than the local agency.**

Providing that a majority of the members do not discuss amongst themselves business "of a specific nature" that is within the subject matter jurisdiction of the agency.

§54952.2(c)(3)

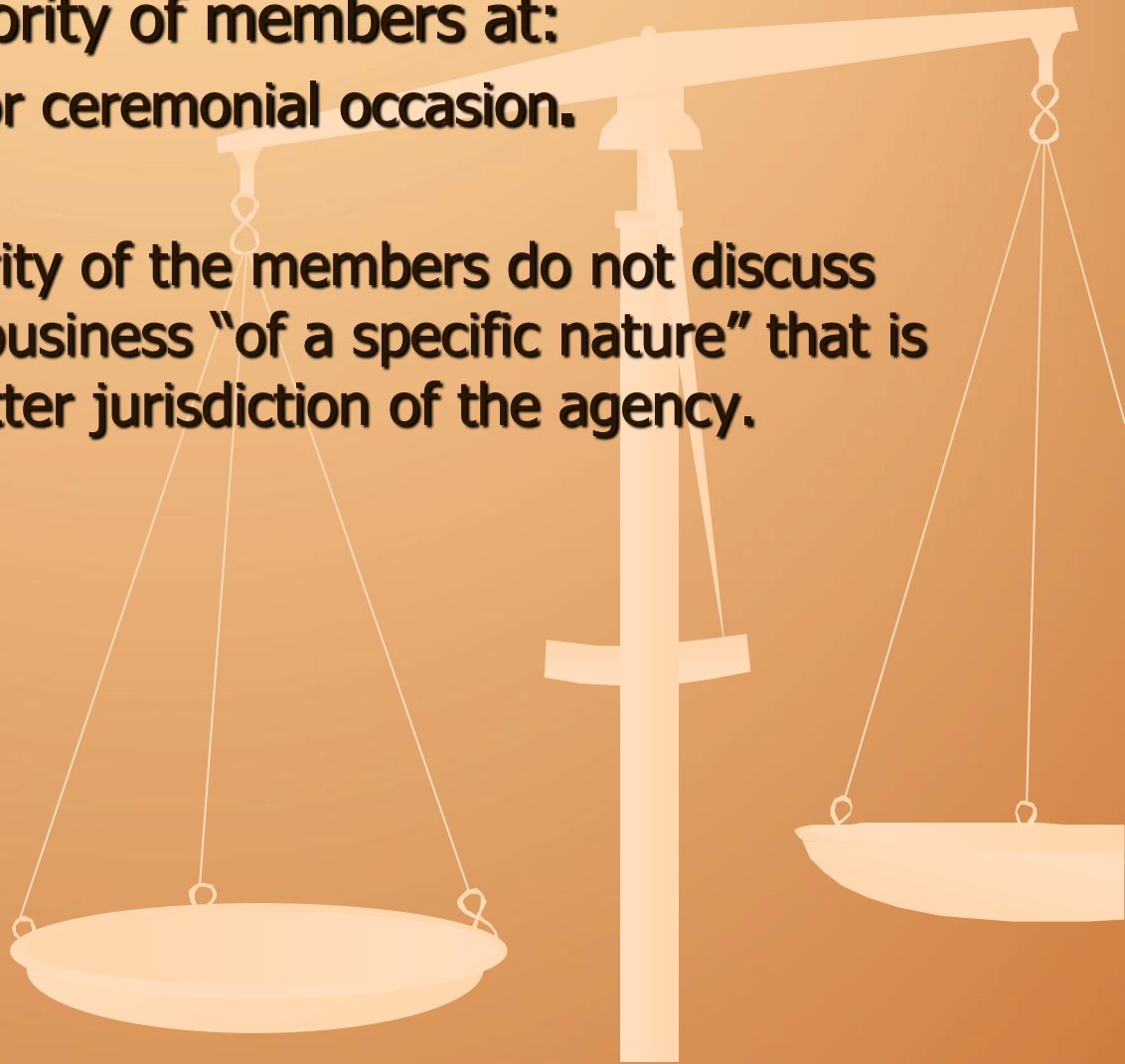


Not a Meeting

- Attendance by a majority of members at:
  - A purely social or ceremonial occasion.

Providing that a majority of the members do not discuss amongst themselves business "of a specific nature" that is within the subject matter jurisdiction of the agency.

§54952.2(c)(5)



III. AGENDA REQUIREMENTS

- Agenda Posting Requirements
- Agenda Description
- Public Comment
- Non-Agendized Items
- Adding Items to an Agenda

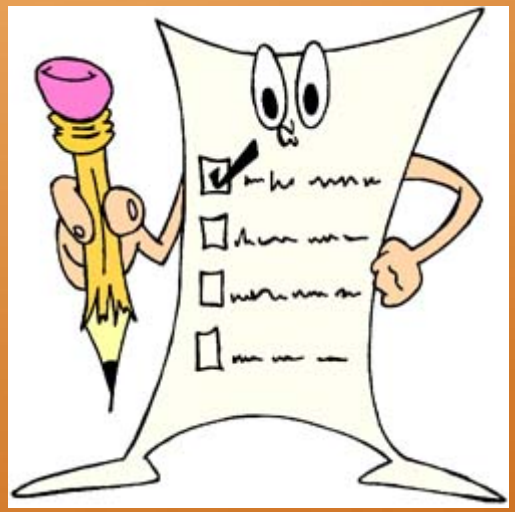
Agenda Posting Requirements

- A **written agenda** must be prepared for each regular or adjourned regular meeting of each legislative body.
- The agenda for a regular meeting must be **posted at least 72 hours** before the meeting.
- As of January 1, 2012, notice of all meeting, including special meetings, must be **posted on the local agency's website,** if the agency has a website.

Agenda Description

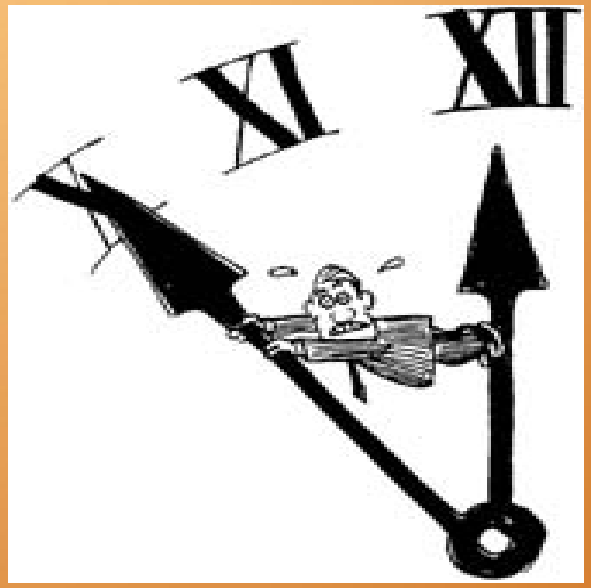
- Each item of business to be "transacted or discussed," including items to be discussed in closed session, must be the subject of a "brief general description" which generally need not exceed 20 words.

§ 54954.2(a)(1)



Public Comment

- Agenda must include a time for public comment before or during the consideration of an agendized item.



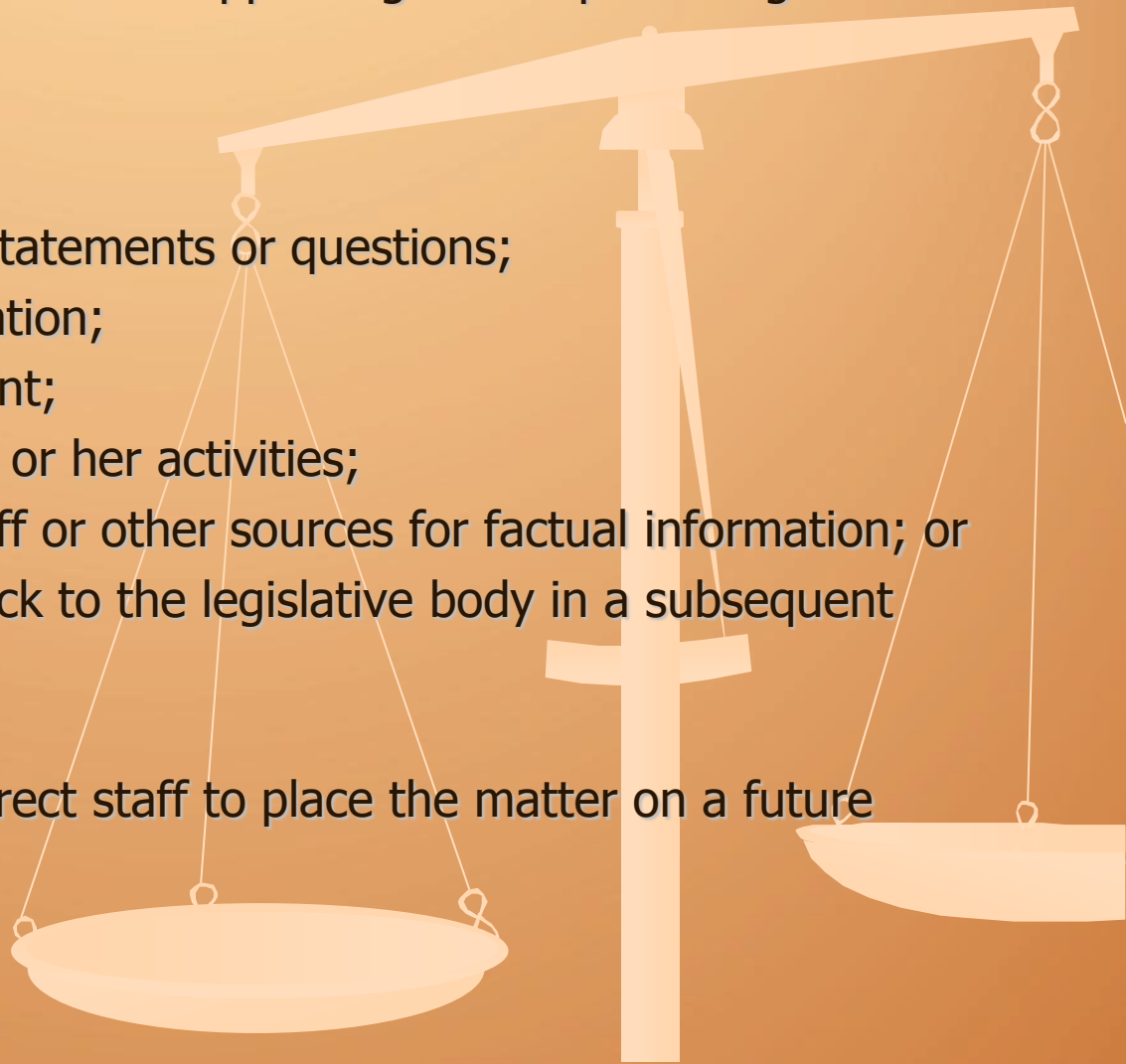
Non-Agendized Items

- Action or discussion of any item not appearing on the posted agenda is generally prohibited.

- Members may only:
  - Briefly respond to public statements or questions;
  - Ask a question for clarification;
  - Make a brief announcement;
  - Make a brief report on his or her activities;
  - Provide a reference to staff or other sources for factual information; or
  - Request staff to report back to the legislative body in a subsequent meeting.

- The legislative body may direct staff to place the matter on a future agenda.

§54954.2(a)(3)



Adding Items to an Agenda

- A legislative body may take action on items of business not appearing on the agenda:
  - When a majority decides that an **emergency** situation exists (i.e., work stoppage, crippling disaster, etc.).
  - When two-thirds present (or all members if less than two-thirds are present) determine there is a **subsequent need to take immediate action** and that the need for action "came to the attention of the local agency subsequent to the agenda being posted."
  - When the item appeared on the agenda of, and was continued from, a meeting held not more than five days earlier.

§54954.2(b)

IV. Public Access to Meetings

- Physical Accessibility
- Meeting Documents
- Right to Record
- Public Participation
- Limits on Public Participation

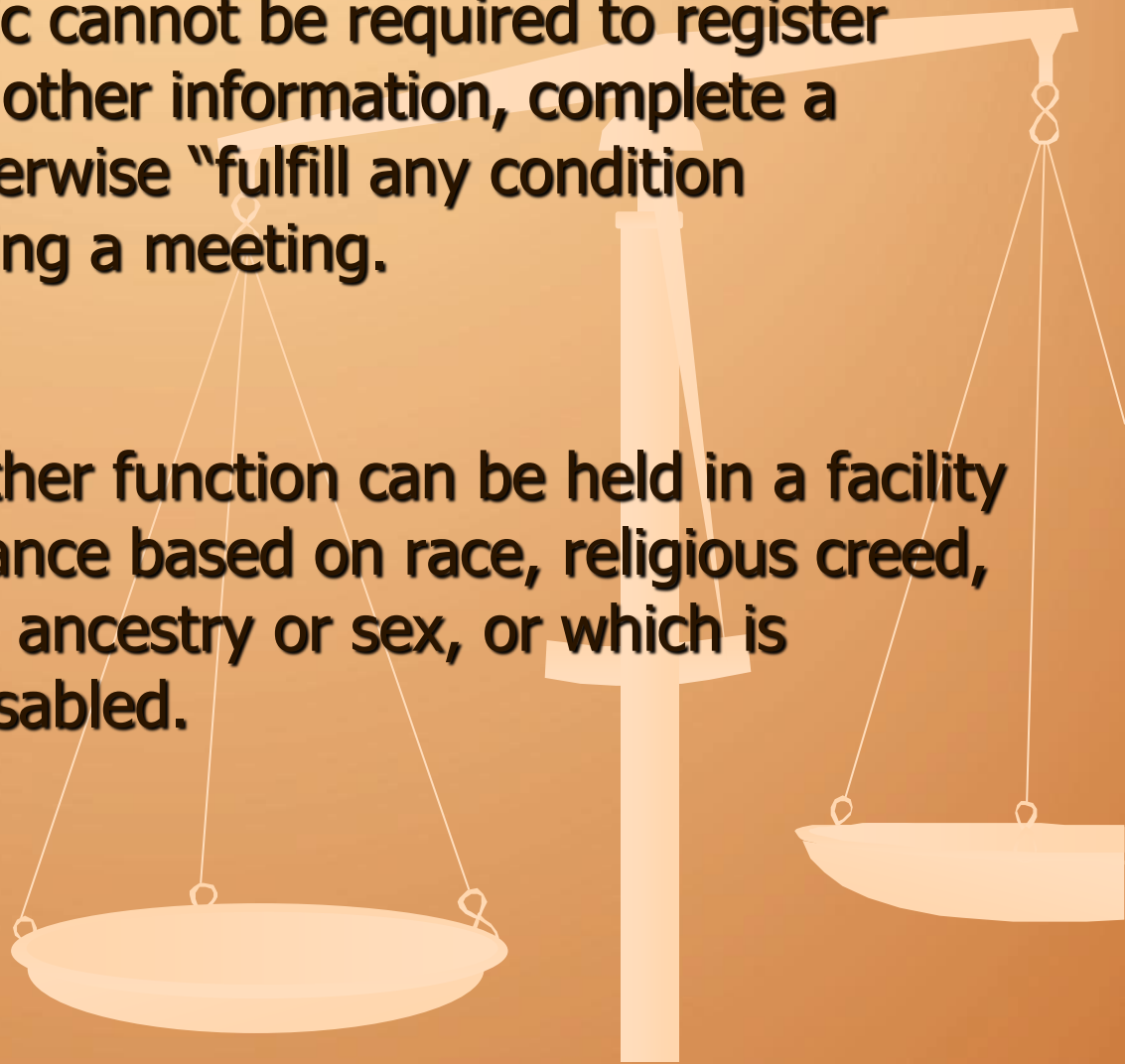
Accessibility

- Members of the public cannot be required to register their names, provide other information, complete a questionnaire, or otherwise "fulfill any condition precedent" to attending a meeting.

  § 54953.3

- No meeting or any other function can be held in a facility that prohibits attendance based on race, religious creed, color, national origin, ancestry or sex, or which is inaccessible to the disabled.

  § 54961(a)



Accessibility

- Meetings must be held in facilities accessible to disabled persons.

  § 54961(a)

- Agendas must include information regarding contact information for requests for disability-related accommodations.

  § 54954.2(a)(1)

- Agendas and other documents must be made available in "appropriate alternative formats" when requested.

  § 54954.2(a)(1)

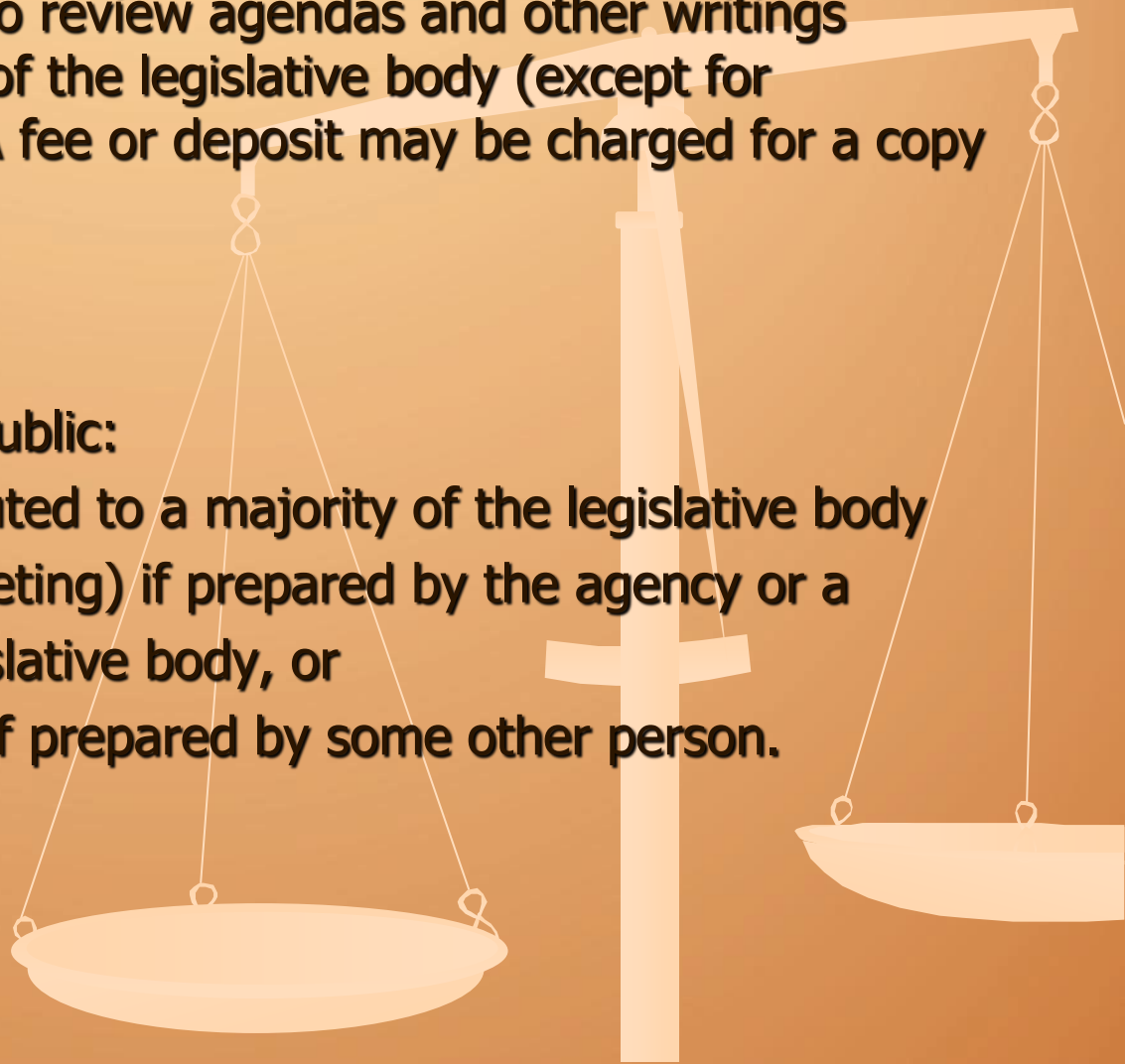
Meeting Documents

- The public has the right to review agendas and other writings distributed to a majority of the legislative body (except for privileged documents). A fee or deposit may be charged for a copy of a public record.

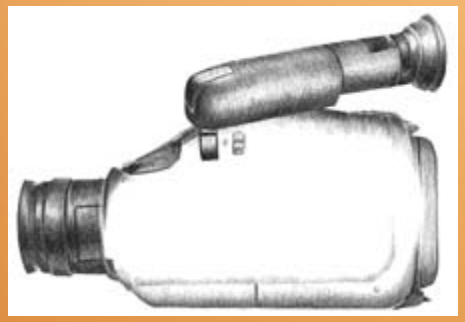
  § 54957.5 (a) and (d)

- Writings must be made public:
  - at the time distributed to a majority of the legislative body (before or at a meeting) if prepared by the agency or a member of its legislative body, or
  - after the meeting if prepared by some other person.

  § 54957.5(b) and (c)



Right to Record



- The public is allowed to use audio or video tape recorders or still or motion picture cameras at an open meeting, absent a reasonable finding by the legislative body that such recording, if continued, would persistently disrupt the proceedings due to noise, illumination, or obstruction of view.

  § 54953.5(a)

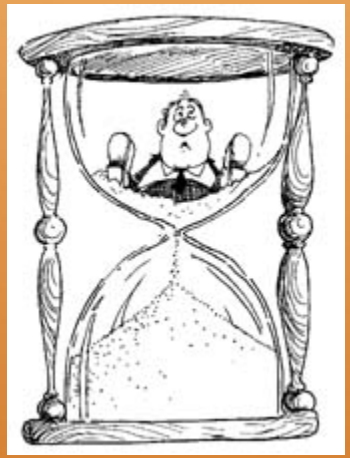
Public Participation

- A regular meeting agenda must allow an opportunity for members of the public to speak **on any item of interest** so long as the item is **within the subject matter jurisdiction** of the legislative body.

- The public must be allowed to speak on a **specific item** of business **before** or **during** the legislative body's consideration of it.

Limits on Public Participation

- The legislative body may adopt reasonable regulations, including time limits, on public comments (*e.g.*, three minutes).



Limits on Public Participation

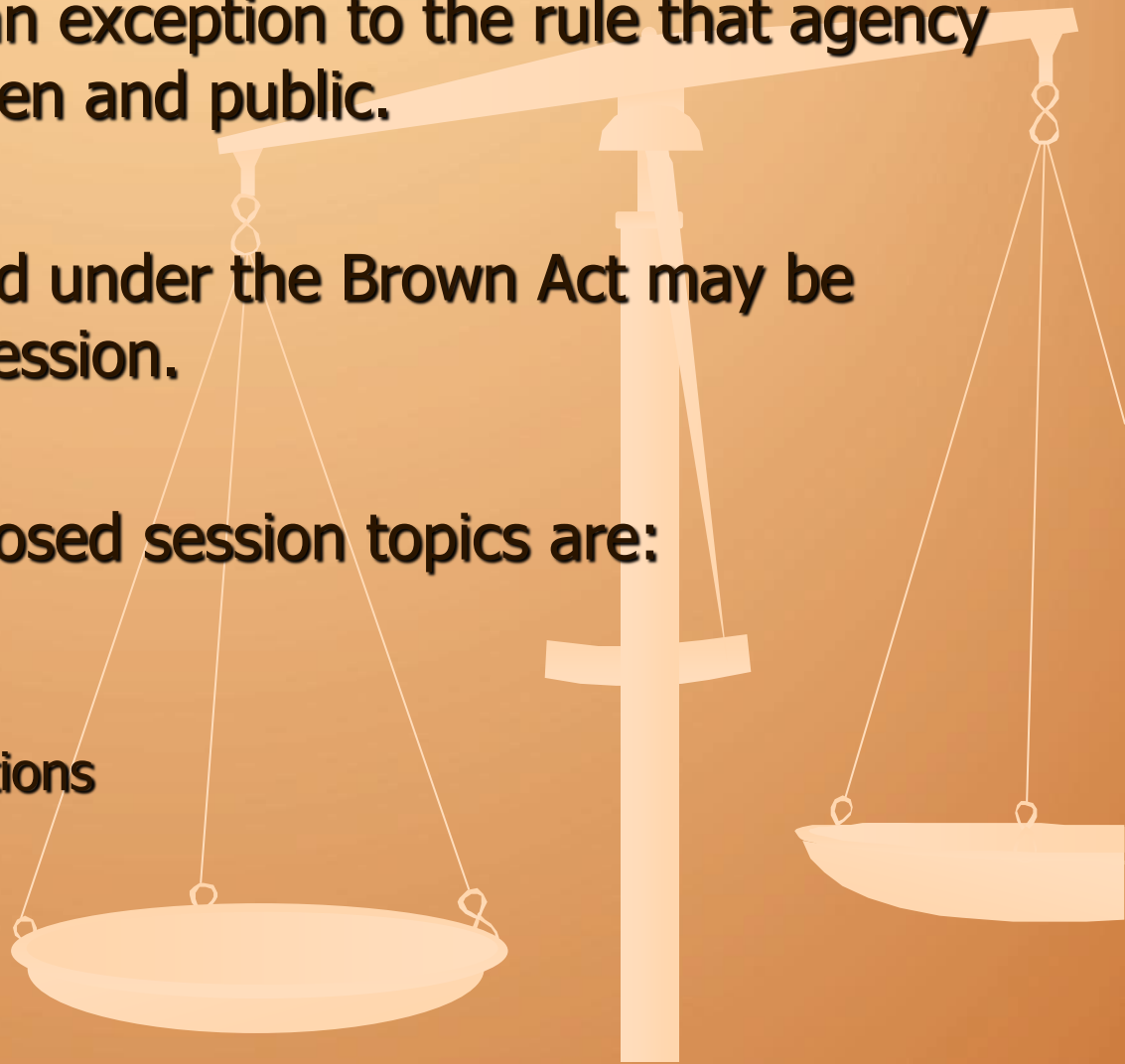
- The legislative body may remove persons from a meeting who willfully interrupt proceedings. If order still cannot be restored, the meeting room may be cleared.

- Members of the news media who have not participated in the disturbance must be allowed to continue to attend the meeting.

§54957.9

V. CLOSED SESSION

- Closed sessions are an exception to the rule that agency meetings must be open and public.
- Only topics authorized under the Brown Act may be discussed in closed session.
- The most common closed session topics are:
  1. Personnel Matters
  2. Litigation
  3. Real Estate Negotiations
  4. Labor Negotiations



Adjournment to Closed Session

- Prior to holding any closed session, the legislative body must disclose, in an open meeting, the item or items to be discussed in the closed session.

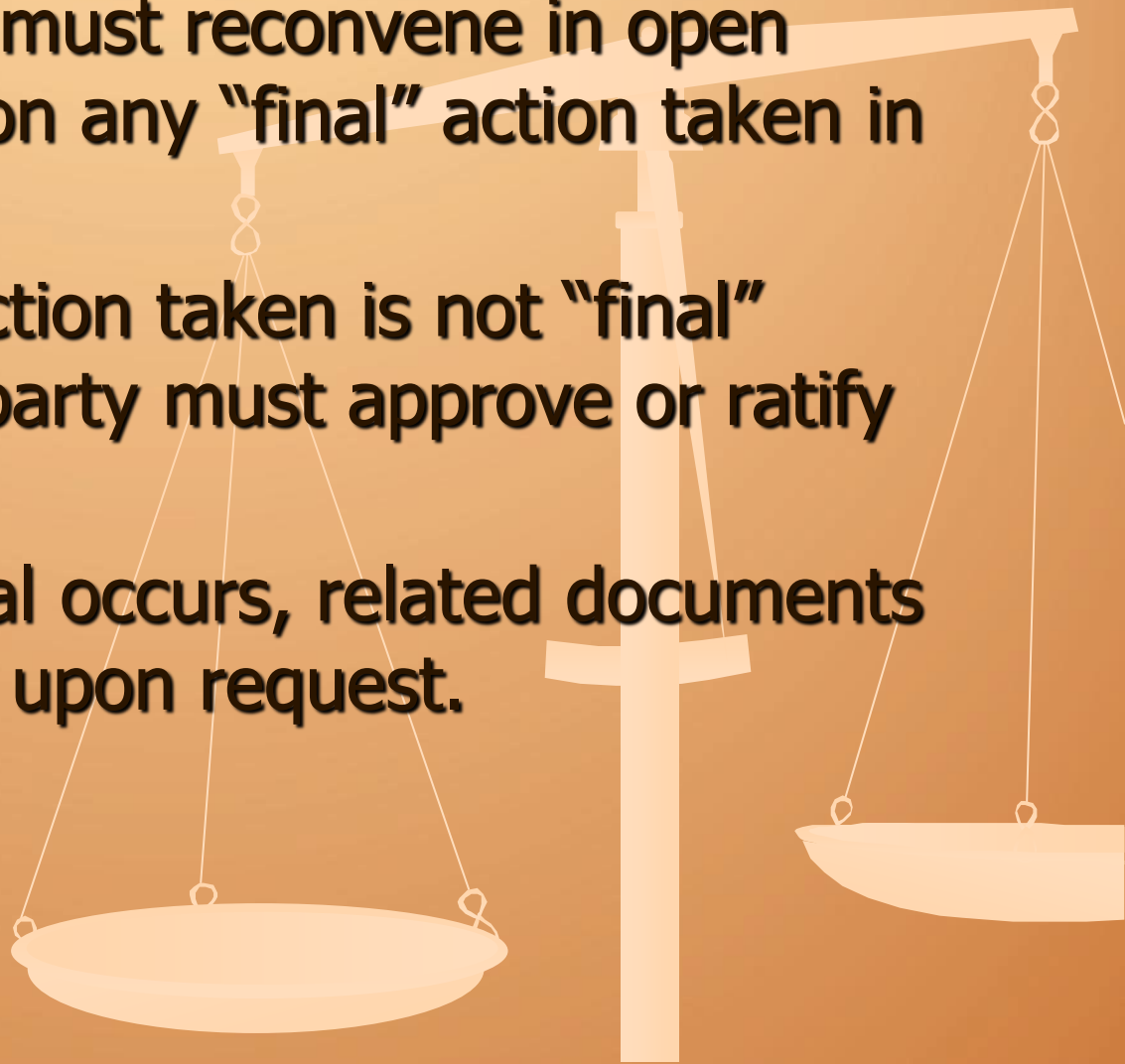
- The public has the right to address the legislative body on closed session items ***before*** it adjourns into closed session.

§ 54956.9(g)

Reporting Out From Closed Session

- A legislative body must reconvene in open session to report on any "final" action taken in closed session.
- Oftentimes, the action taken is not "final" because another party must approve or ratify the agreement.
- Once final approval occurs, related documents must be disclosed upon request.

§ 54957.1

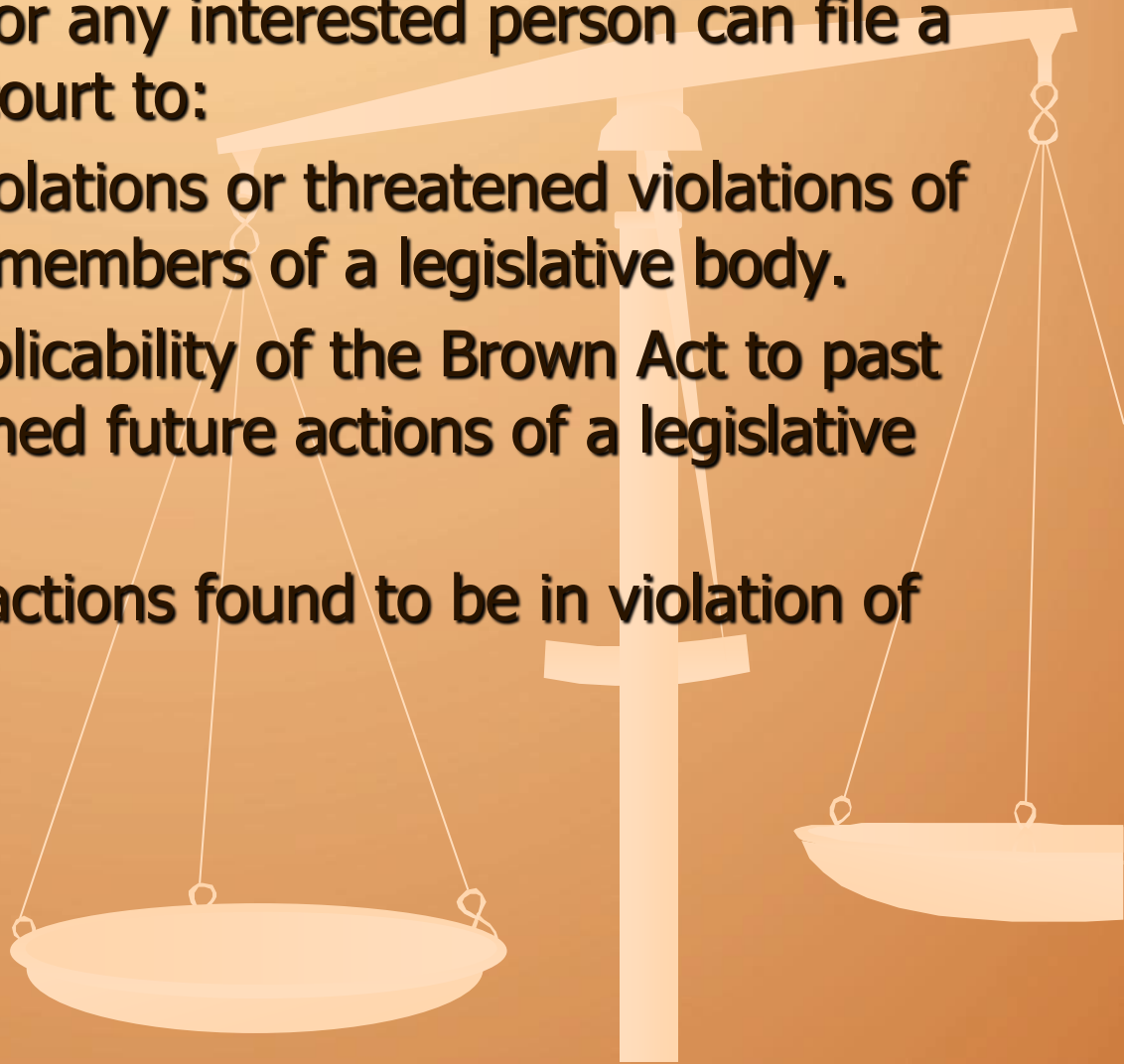


VI. LEGAL CHALLENGES

Civil Actions

- The district attorney or any interested person can file a civil action asking a court to:
  - Stop or prevent violations or threatened violations of the Brown Act by members of a legislative body.
  - Determine the applicability of the Brown Act to past actions or threatened future actions of a legislative body.
  - Void certain past actions found to be in violation of the Brown Act.

§§ 54960, 54960.1, 54960.2



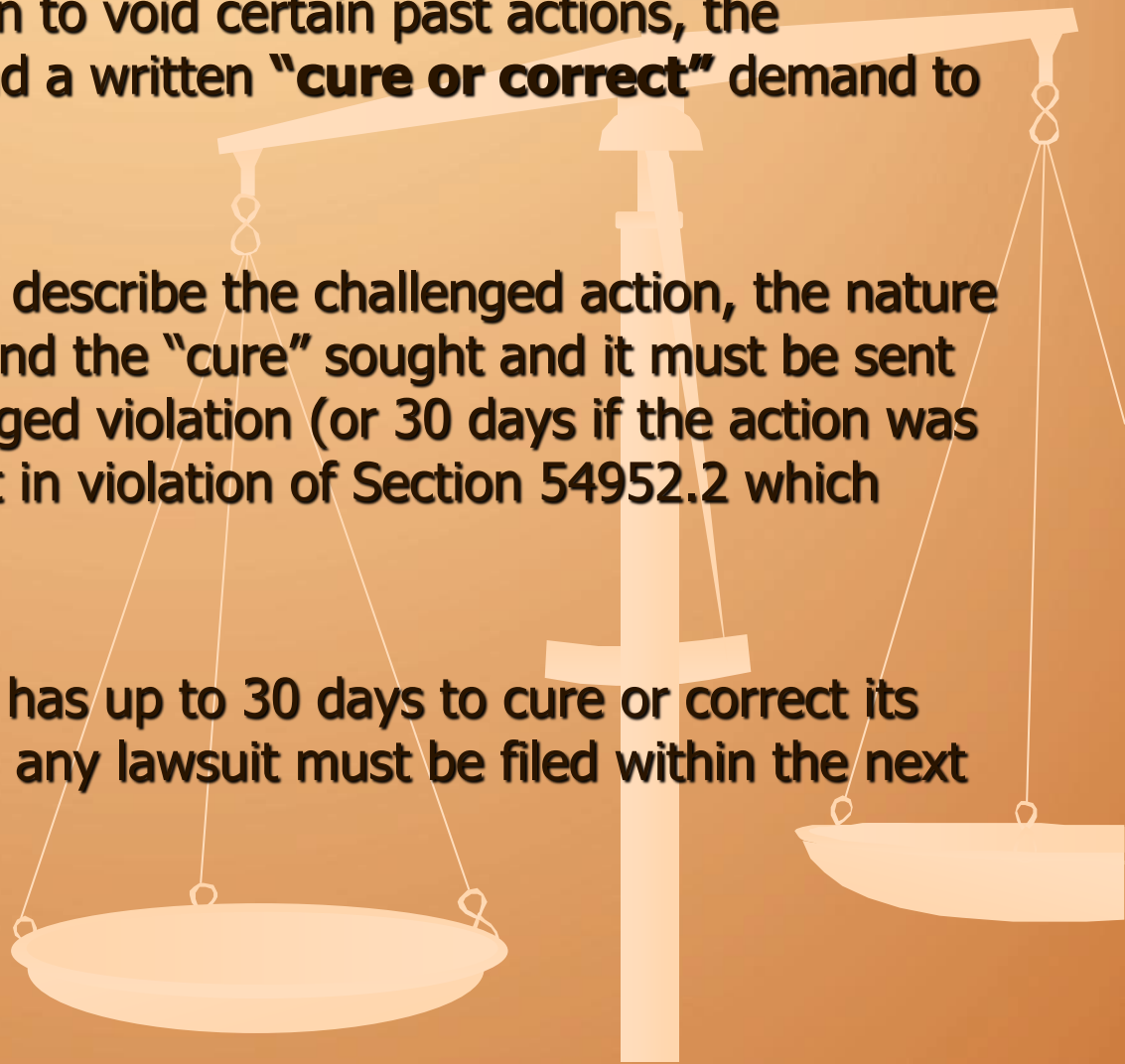
Opportunity to Cure

- Before filing a court action to void certain past actions, the aggrieved party must send a written **"cure or correct"** demand to the legislative body.

- The demand must clearly describe the challenged action, the nature of the alleged violation, and the "cure" sought and it must be sent within 90 days of the alleged violation (or 30 days if the action was taken in open session but in violation of Section 54952.2 which defines "meetings.")

- The legislative body then has up to 30 days to cure or correct its action. If it does not act, any lawsuit must be filed within the next 15 days.

§ 54960.1



Cease & Desist Commitment

- Before filing a court action to declare certain past actions in violation of the Brown Act, the aggrieved party must submit a written "cease and desist" letter to the legislative body.
- The letter must clearly describe the nature of the alleged violation, and must be sent within 9 months of the alleged violation.
- The legislative body then has up to 30 days to issue an "unconditional commitment" to cease and desist from the past action.
- If the body fails to respond or issue the commitment, then the individual then has 60 days from the date of the response or the expiration of the response period to file a lawsuit.
- A legislative body may rescind a cease and desist commitment at an open, regular meeting upon 30 days notice to the aggrieved party.
- Upon such notice, the aggrieved party may commence an action under § 54960 to prevent such threatened action.

§ 54960.2

Costs and Attorney Fees

- If the court finds the legislative body violated the Brown Act, the plaintiffs may get costs and attorneys' fees.

- A public entity may get costs and attorneys' fees if it wins only if the lawsuit was "clearly frivolous and totally lacking in merit."

THE BEST SOLUTION IS PREVENTION

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Does cloud seeding really work?

Researchers are combining studies of ice formation with remote-sensing techniques to give rainmaking scheme a firm scientific footing

By Janet Pelley, special to C&EN

A plane launches a flare to seed clouds over North Dakota.

Credit: Jim Brandenburg/Minden Pictures/Newscom

The pilots at Weather Modification Inc. were standing by on alert on Aug. 12, 2012, when they got word from their staff meteorologist to jump in their planes and head toward a budding thunderstorm just west of Calgary, Alberta. Their mission: to prevent the formation of crop-destroying, car-denting hail by shooting flares loaded with silver iodide into cumulus clouds.

Some of the pilots headed for the smooth, rain-free base of the clouds at 2,000 meters, where updrafts could pull the inorganic compound in. Other pilots flew to 5,500 meters, penetrating the tops of the billowy formations.

Once in position, the aviators ejected the flares mounted on their planes. Theoretically, the silver iodide particles that spewed forth would catalyze supercooled water droplets in the clouds to freeze at a warmer temperature and more abundantly than they might have otherwise. The pilots hoped that this maneuver would redistribute the water vapor in the clouds, releasing rain and small hailstones rather than the large golf-ball-sized ones that had been predicted.

Afterward, radar data revealed a storm nearly 27% less severe than what had been projected, says **Terry Krauss <https://www.linkedin.com/in/terry-krauss-40ba0231>** , a meteorologist with the Alberta Severe Weather Management Society, a nonprofit agency funded by insurance firms. "Our data show that the seeding may have avoided up to C$100 million in damage to homes and cars," he says. On a severe storm day, he adds, even a 1% reduction in hail intensity will more than pay for the annual C$4 million cost of Alberta's hail suppression program.

Not only has cloud seeding been used to mitigate hailstorms for years, it has also been used to try to enhance rain- and snowfall for water storage in reservoirs and in the ground. These small-scale projects are not to be confused with geoengineering schemes that propose tinkering with the planet's weather by modifying Earth's ability to reflect solar energy. Currently, more than 50 countries worldwide participate in cloud-seeding operations.

And these operations are growing in popularity. Almost half of the world's population will be living in water-stressed areas by 2030, **according to estimates from the United Nations <http://www.un.org/waterforlifedecade/scarcity.shtml>** . This year, the United Arab Emirates (U.A.E.) **awarded $5 million <http://www.uaerep.ae/en>** to rain enhancement researchers in Japan, Germany, and the U.A.E. to address the problem.

So it seems odd then that cloud seeding, so heavily touted, hasn't actually been statistically proven to work. After the method was first tested 70 years ago, enthusiasm for cloud seeding

led to experiments that claimed annual precipitation increases of 10% or more. But the studies lacked statistical rigor. And running control experiments in cloud-seeding studies is a challenge: Once a cloud is treated, you can't measure how much it would have rained or snowed if left unseeded. Even the basic mechanics underlying the crystallization of water molecules on seeding agents remains mysterious.

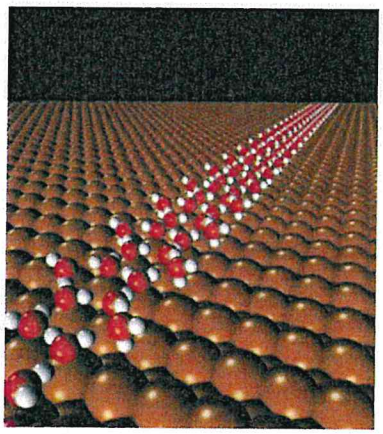
After the 1980s, with few results to show for the millions of dollars invested in research, studies on weather modification dropped to a trickle. Yet over the past decade, advances in remote-sensing and modeling and new work on the physics of ice formation are reviving hopes for a more solid scientific footing for cloud seeding.

The puzzle of ice initiation

Modern-day cloud seeding was launched in the lab of noted surface scientist Irving Langmuir at General Electric in 1946. His colleagues Vincent Schaefer and Bernard Vonnegut, brother of author Kurt, **discovered that silver iodide <http://cen.acs.org/articles/85/i25/Ice-Nines-Concept.html>** could transform supercooled water vapor into ice crystals at temperatures of −10 to −5 °C. In nature, clouds form when supercooled water vapor condenses and then freezes onto particles, called ice nuclei, made of dust and even bacteria. Droplets of pure water can't form an ice crystal nucleus until the temperature drops to −40 °C. Yet if clouds contain aerosol particles, water molecules can use the solid surfaces of these "seeds" to organize themselves into a crystalline form at much warmer temperatures, from −20 to −5 °C.

Reasoning that precipitation must be limited by the scarcity of natural ice nuclei in the air, Schaefer and Vonnegut began atmospheric trials to inject artificial nuclei into clouds, and an industry was born. The researchers suggested that silver iodide was a good nucleating agent because its hexagonal crystalline lattice is nearly identical to the lattice that water molecules form in ice and snowflakes—one in which units of six water molecules assemble. Silver iodide is the seeding agent of choice for cold clouds, although firms also deploy potassium chloride and dry ice, says **Bruce Boe <http://www.weathermodification.com/about-us-team.php>** , vice president of meteorology at **Weather Modification Inc. <http://www.weathermodification.com/>**

"Vonnegut's proposal that silver iodide is an effective ice-nucleating agent because it provides a hexagonal crystalline template similar to that of ice is a compelling view that's been widely accepted," says **Angelos Michaelides <http://www.london-nano.com/our-people/academics/angelos-michaelides>** , a theoretical chemist at University College London. But there is no basis for this claim because scientists have not yet established the exact mechanism of the freezing process. "We still know rather little about the structures water forms as it transforms from the liquid to the solid state, particularly when this process happens at the surfaces of other materials such as silver iodide," he says.



In this simulation, water molecules (red and white) form a pentagonal lattice when they stick to a copper surface.
Credit: Courtesy of Angelos Michaelides

Ice nucleation is hard to probe experimentally because current imaging instruments don't produce clear pictures of individual molecules as they freeze, Michaelides says. So he and his colleagues have created nanoscale computer simulations that interpret results from physical images. The simulations predict the interactions between molecules on the basis of the rules of quantum mechanics.

In 2009, for instance, Michaelides and his team collaborated with experimentalists at the University of Liverpool who used scanning tunneling microscopy to detect water freezing on a

copper surface. The simulations run on the resulting imaging data provided strong evidence that the 1-nm-wide chains that formed on the copper surface were not built from water hexagons—the traditional ice lattice—but from groups of five water molecules bonded into pentagons (*Nat. Mater.* 2009, DOI: **10.1038/nmat2403 <http://dx.doi.org/10.1038/nmat2403>**).

These results suggested that perhaps Schaefer and Vonnegut's hypothesis about what makes silver iodide such a good nucleating agent wasn't correct. So more recently, Michaelides and his team computationally designed a theoretical set of surfaces, varying the extent to which their crystal structures matched ice. Allowing ice to nucleate on the surfaces via a computer simulation, the scientists found that there was no simple correlation between the similarity of a surface to ice and its ability to nucleate ice (*J. Am. Chem. Soc.* 2015, DOI: **10.1021/jacs.5b08748 <http://cgi.cen.acs.org/cgi-bin/cen/trustedproxy.cgi?redirect=http://pubs.acs.org/doi/abs/10.1021/jacs.5b08748?source=cen>**).

Similarly, **a recent investigation of ice-nucleating bacteria <http://cen.acs.org/articles/94/i17/Making-ice-microbe-style.html>** also suggests that surfaces don't have to match the structure of ice crystals in order to nudge water into its solid phase. Ski resorts dose their snowmaking machines with the bacteria *Pseudomonas syringae* because proteins on its surface freeze water at temperatures around the melting point of ice (0 °C). "Yet no one understood the molecular mechanism by which the proteins trigger freezing of water," says **Tobias Weidner <http://www.mpip-mainz.mpg.de/89016/Dr_Tobias_Weidner>** , a physicist at the Max Planck Institute for Polymer Research.

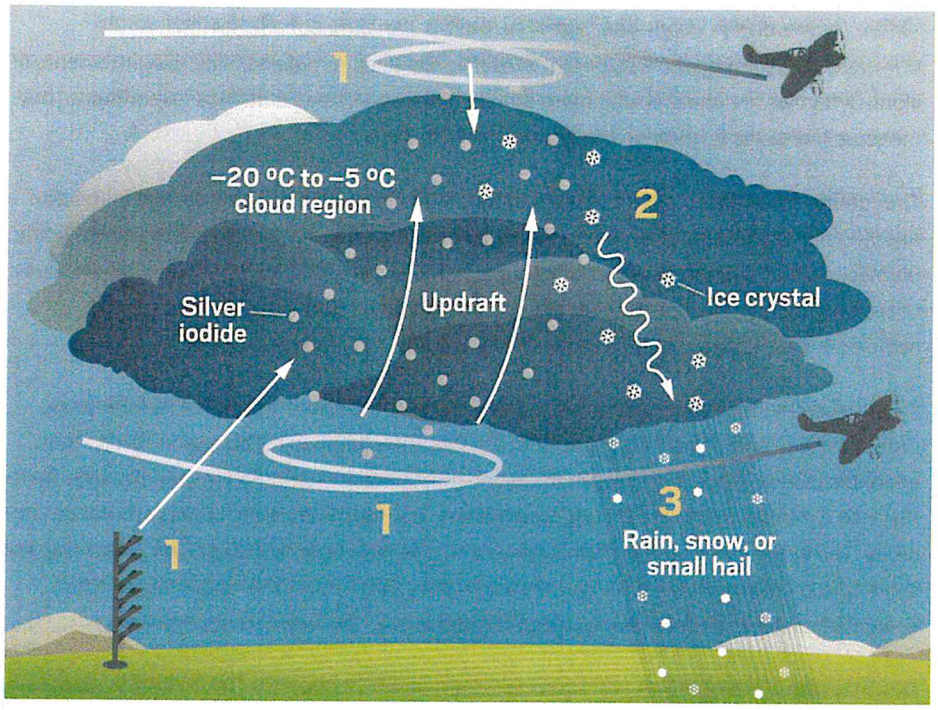
Weidner and his colleagues used sum frequency generation spectroscopy and computer simulations to demonstrate that the proteins on the outer membrane of the bacteria create alternating hydrophobic and hydrophilic sites (*Sci. Adv.* 2016, DOI: **10.1126/sciadv.1501630 <http://dx.doi.org/10.1126/sciadv.1501630>**). This simple arrangement promotes ice crystal formation by manipulating water molecules into tight patterns of high and low density. If someone wanted to make a new cloud-seeding agent, maybe a polymer particle, "it might be possible to engineer this hydrophobic and hydrophilic pattern on a nanoscale," Weidner says.

All these findings are getting scientists closer to identifying what makes a good ice-nucleating agent and why. "We hope this will lead to a general theory that will have predictive value used to design and identify new materials we can control ice formation with," Michaelides says.

Probing clouds

Last year marked the conclusion of a massive six-year study that has been the most comprehensive and rigorous to date to investigate whether cloud seeding actually increases precipitation. Called the **Wyoming Weather Modification Pilot Project <http://www.ral.ucar.edu/projects/wyoming/>** (WWMPP), the study was run by a team of researchers from government, academia, and private industry. In the end, WWMPP wasn't able to provide a definitive answer. "But the results do provide a body of evidence that cloud seeding is working under certain conditions," says **Roelof Bruintjes <https://www.rap.ucar.edu/staff/roelof-staff.php>** , an atmospheric scientist at the National Center for Atmospheric Research (NCAR), who was not part of the project although his colleagues at NCAR were deeply involved.

Earlier studies would inject silver iodide into clouds, then compare precipitation gauges in areas inside and outside the seeding zone. But the studies weren't repeatable, and they didn't include enough trials to guarantee that observed increases in precipitation weren't due to chance. The challenge with measuring the effect of weather modification is that natural rain- and snowfall variability is 10 to 100 times as large as the amount of precipitation augmented by seeding, Bruintjes says.



How cloud seeding is supposed to work
Weather modification firms launch silver iodide flares from planes or from the ground into cloud formations to try to increase rainfall or mitigate hailstorms.

1. Some planes drop flares from above the cloud formation. Some planes release silver iodide from flares into an updraft. Some operations shoot silver iodide flares into clouds from the ground.

2. Silver iodide helps form ice nuclei that can fall as rain or snow and steal moisture from larger hail particles.

3. Ice crystals fall, coming down as rain, snow, or small hail particles, depending on the conditions.

Credit: Yang H. Ku/C&EN/Shutterstock

Still, the WWMPP researchers thought they could address the drawbacks of past studies. The researchers designed their $14 million project to run for six winter seasons in the mountains of Wyoming. They conducted more than 150 tests, randomly selecting clouds to seed and clouds to be their unseeded controls.

Measurements from the high-resolution snow gauges on the ground indicated that seeding elevated snowfall by 5–15%. But this result was achieved only after the researchers threw out some of the tests where silver iodide drifted into control clouds or where not enough seeding material was released, so the final results weren't statistically significant. "Nevertheless, all the results provided evidence for a positive trend," Bruintjes says.

The scientists also took advantage of new developments in remote-sensing and atmospheric modeling to examine dynamics inside a small subset of seeded clouds.

Using cloud radar, a laser-based version of radar known as lidar, and other techniques, the team examined the chain of events, beginning with the distribution of the seeding material then moving to the conversion of supercooled liquid water into ice and finally to the deposition of snowfall. With the reflectance signal from lidar in particular, the researchers were able to monitor the real-time decline of supercooled liquid water as it condensed on the silver iodide particles. Cloud radar tracked the increase in the number of snow particles.

Remote-sensing observations are valuable because radar can describe growth of snow in a cloud in a much more immediate way than snow gauges can, says **Bart Geerts**

<http://www.atmos.uwyo.edu/~geerts/bart/> , an atmospheric scientist at the University of Wyoming who was part of WWMPP. "Detailed remote-sensing measurements of cloud dynamics are cheaper and more doable than randomized statistical experiments that measure increases in snow on the ground," Geerts says.

The remote-sensing equipment combined with modeling confirmed an increase in the size and number of snow particles within the cloud after seeding. "In the core of the silver iodide plumes, we may see the snowfall rate double or more, according to the model," Geerts says. In the end, though, the researchers did not have enough remote-sensing data over a sufficiently long period of time to quantify the impacts they thought they saw.

Another climate modeling experiment conducted over eight winters in the WWMPP study area, however, estimates that about 30% of winter precipitation in the region comes from seedable clouds. Not every cloud in the mountains meets the criteria for seeding, says Jaclyn Ritzman, a meteorologist at the National Oceanic & Atmospheric Administration who ran the study. The temperature and the wind speed and direction have to be just right. Assuming that seeding promotes about a 10% rise in precipitation, Ritzman and her team suggest that seeding could augment the snowpack by a maximum of 3% over an entire season.

Nevertheless, not everyone is convinced of cloud seeding's benefits. The WWMPP report's findings are not too different from the conclusions drawn over a decade ago by the National Academy of Sciences (NAS) in a **report on weather modification <http://www.nap.edu/catalog/10829/critical-issues-in-weather-modification-research>** , says **Rob Jackson <https://earth.stanford.edu/rob-jackson>** , an ecologist at Stanford University. The NAS report concluded that it is difficult to show clearly that cloud seeding has a very large effect. "I think you can squeeze out a little more snow or rain in some places under some conditions, but that's quite different from a program claiming to reliably increase precipitation," he says.

Concerns remain

Even if cloud seeding does succeed at increasing precipitation, environmental activists are concerned about its impact. One scientist addressing those concerns is geochemist **Shawn Benner <https://earth.boisestate.edu/people/shawn-benner/>** at Boise State University. "The near impossibility of detecting a silver iodide signal in snowpack after seeding attests to its low environmental risk," Benner says.

Natural background levels of silver iodide in snow are about 1 to 2 parts per trillion, and after seeding, researchers look for levels from 4 to 20 ppt. Although silver is toxic to aquatic organisms in large doses, the levels found in surface water after seeding are well below the toxic threshold of 50,000 ppt, Benner says. "Nevertheless, if the practice of cloud seeding intensifies at a larger scale, silver toxicity and other environmental issues could become a concern," Jackson says.

Aside from the toxicity of silver, some cloud-seeding critics raise concerns about messing with the balance that Mother Nature holds on the atmosphere. The amount of moisture in the atmosphere is determined by the balance between evaporation and precipitation. If cloud seeding is done on a large scale, it might lead to increased evaporation from locations outside the seeding area, Jackson says. "It's obvious that rain falling in one place would have fallen somewhere else, but the broader question is, who, if anyone, would have seen the rain and what else might it affect?" he adds.

Atmospheric budgets suggest that cloud seeding is unlikely to steal moisture from downwind sites, responds Weather Modification's Boe. Because clouds represent a modest portion of the moisture in the atmosphere, a cloud-seeding effect of 15% would only remove about 1–2% of the total water vapor in the seeding area, he contends.

As chronic drought settles into parts of the Great Plains and western U.S., state and local water agencies don't seem to be troubled by the uncertainties of cloud seeding, in part

because the costs are so small compared with the potential benefits. A new study from the **Texas A&M AgriLife Extension Service estimates <http://www.texasweathermodification.com/NEW/Benefit%20Cost%20Analysis%20of%20Texas%20Weather%20M** that if cloud seeding augments annual rainfall by one inch, then for every dollar invested in weather modification, $19 is returned through more bountiful harvests and the use of less irrigation.

"But at present, making it rain is still more of an art than a science," Jackson says. With countries increasingly spending hundreds of millions of dollars on weather modification, he argues, more research is needed to understand if the practice works and what its environmental, social, and governance impacts will be.

This article has been translated into Chinese <http://cen.acs.org/articles/94/i22/Does-cloud-seeding-really-work-cn.html> and can be found here. <http://cen.acs.org/articles/94/i22/Does-cloud-seeding-really-work-cn.html>

To see all of C&EN's articles that have been translated into Chinese, visit **http://cen.acs.org/cn.html <http://cen.acs.org/cn.html> .**

Chemical & Engineering News
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Comments

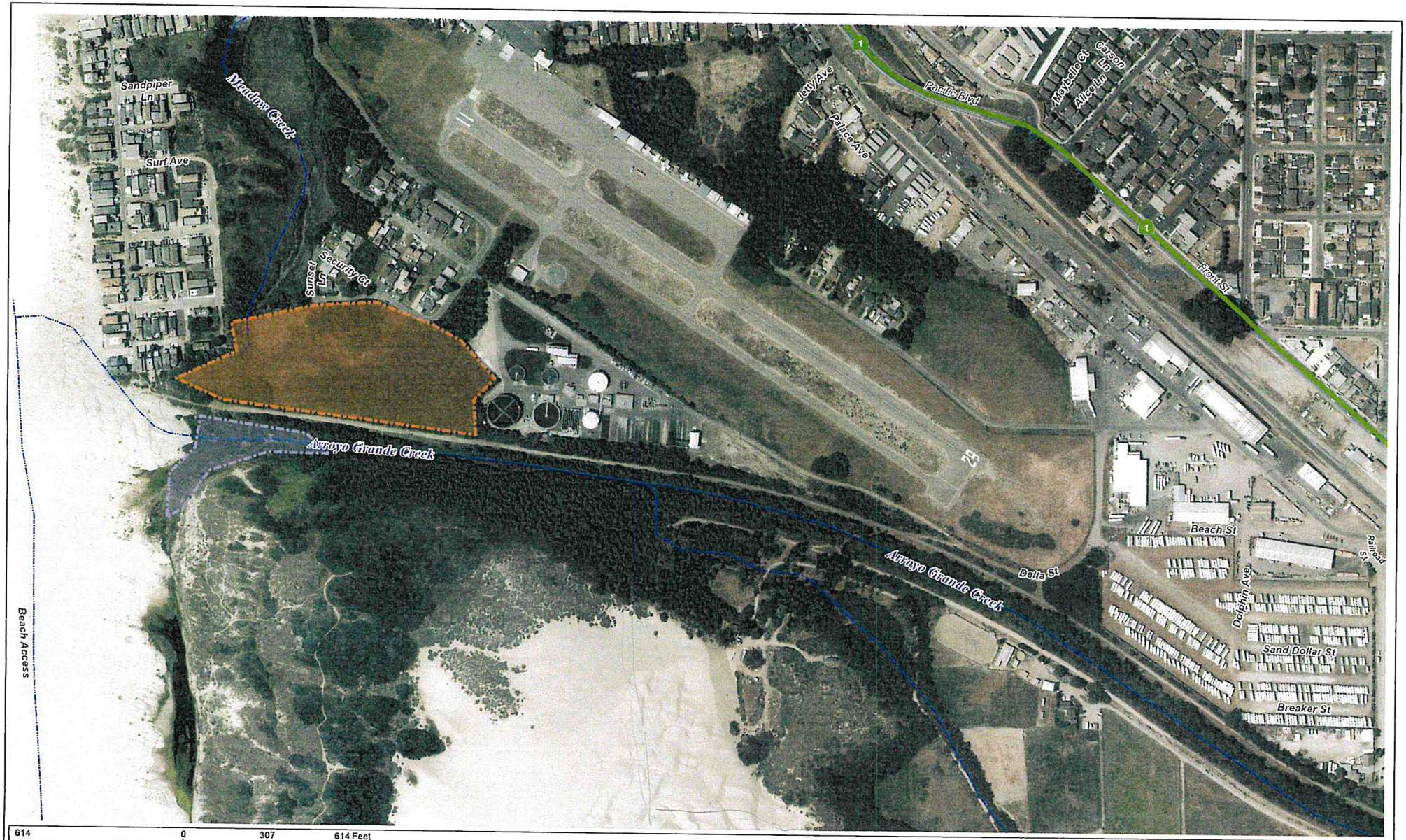
mansur abahusayn (August 21, 2016 7:18 PM)
Turbulence, sound and smoke from the cloud seeding plane may be responsible for the meager statistically insignificant variation claimed by WM enthusiasts. When one considers the percent of rain evaporated before rain it reaches the ground, evaporated by the soil, plants and after reaching the ground, it will be difficult to conclusively prove the cloud seeding benefits, let alone all the legal issues and claims of damages that may have taken place irrespective of cloud seeding. More research money should go to the understanding of the mechanisms of vapor to liquid/ice transformation and aggregation of water droplets rather than cloud seeding based on assumptions that have no concrete scientific evidence. The density of a cloud water aerosol in the cloud air is one in a million at best. That aerosol is in a dynamic states of evaporating and condensing all the time. How much additional nuclei does silver iodide add to that already present in the atmosphere? Is the atmosphere really short of nuclei?
Reply »

Prof Panchanan Pramanik (August 29, 2016 2:02 AM)
The mechanism of cloud formation from forest volatile is not clear. If it is understood well then controll of rain is easier and cheaper . We found some interesting observation over this .
Reply »

Atanacio Luna (January 9, 2017 11:35 PM)
Mansur: If the net result is increased rain, even if from cloud and smoke, although I am not sure sound is a factor, so much the better, the objective is still achieved. More knowledge is always better, but doing may be more important for development of an art or a science sometimes. I say keep working at it, keep studying the process, and keep trying to improve the technique and the measurements.
But I came to ask a question. Is it possible to cause condensation of water from latent heat, even if it does not cause rain, at higher temperatures? Please email any ideas on this to Pluvinergy@gmail.com. Thanks
Reply »

Prof Mansur Abahusayn (February 24, 2017 4:16 PM)
Atanacio: Over 70 years of research have gone to cloud seeding to increase rainfall, and the results are inconclusive at best, please see (http://cen.acs.org/articles/94/i22/Does-cloud-seeding-really-work.html). Some of the hundreds of millions of dollars dedicated to cloud seeding should be directed at new ideas and patents.
Extracting moisture from clouds, fog and the like has the advantage that the huge energy required to condense water vapor to liquid is avoided. The process of cloud water micro-droplets to rain is probably an entropy rather than thermal demand. Sound, as expressed in thunder, has the effect of increasing turbulence and mixing which enhances coalescence of micro-droplets to larger drops that fall as rain in warm clouds.
Reply »

gaylord shields (April 29, 2017 5:57 PM)
does seeding a cloud change the direction of travel
Reply »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Surf Ave
Sunset Ln
Security Ct
Jetty Ave
Palace Ave
Pacific Blvd
Maybelle Ct
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Front St
Arroyo Grande Creek
Beach Access
Arroyo Grande Creek
Delta St
Beach St
Railroad St
Dolphin Ave
Sand Dollar St
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Department of Planning & Building

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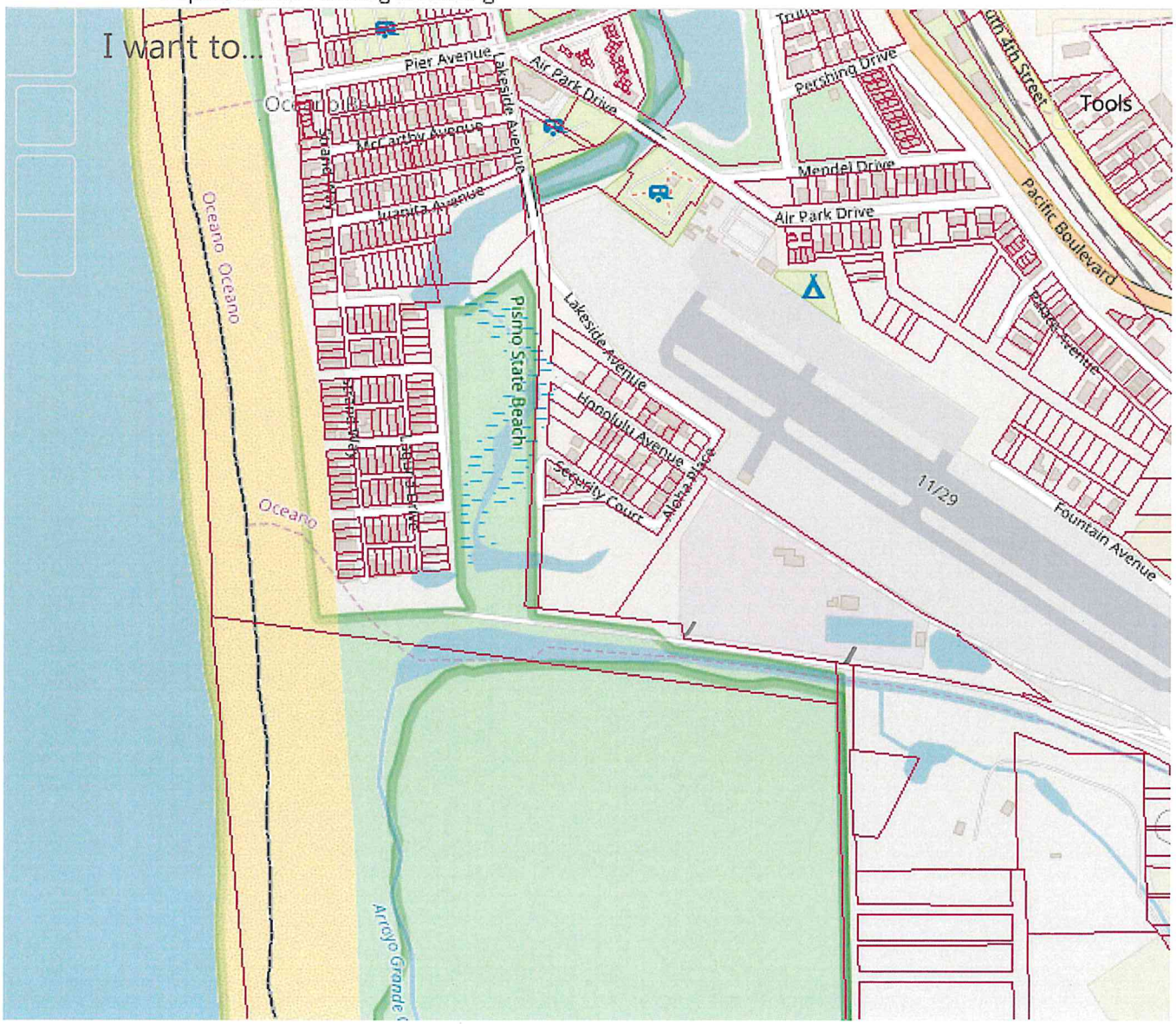

Basemaps

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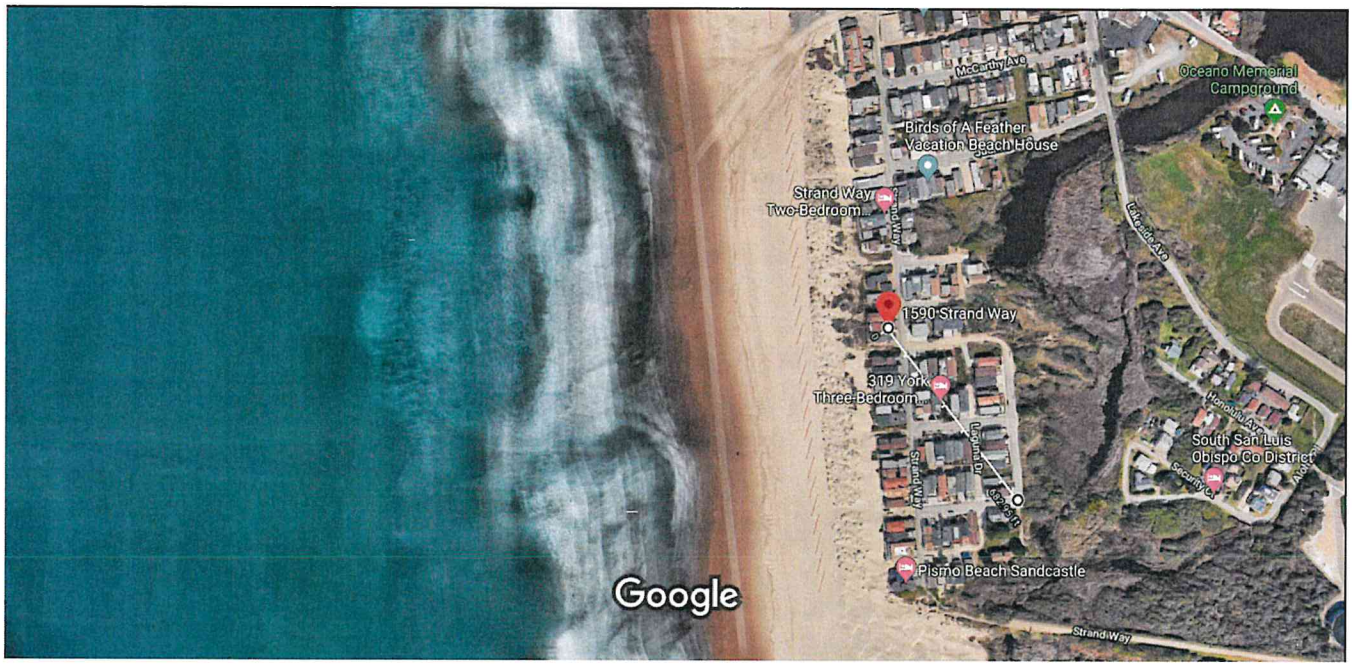
Google Maps 1590 Strand Way



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1590 Strand Way

Oceano, CA 93445

Measure distance

Total distance: 682.95 ft (208.16 m)