2011 Osoyoos Lake Water Science Forum Shared Water, Shared Future: Bridges to Sustainability for Osoyoos Lake September 18-20, 2011

SUMMARY REPORT

Prepared for:

Osoyoos Lake Water Science Forum Organizing Committee
c/o Stu Wells
Town of Osoyoos
8707 Main Street
Osoyoos, BC V0H 1V0

Prepared by:

Clint Alexander
ESSA Technologies Ltd.
1479 Aspen Court
Kelowna, BC V6J 5C6

Kellie Garcia
Insight Environmental Consulting Ltd.
38-1985 Burtch Road
Kelowna, BC V1Y 4B4

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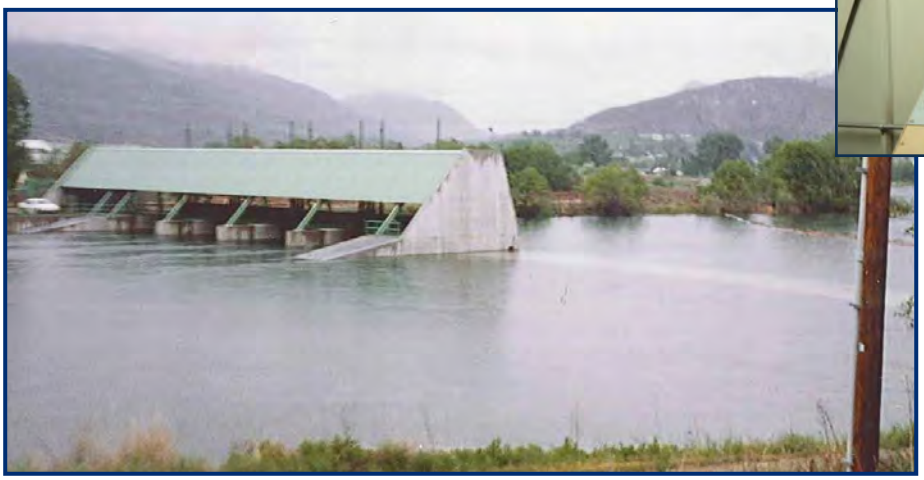
Photograph by Hartmut Suhling
(http://www.panoramio.com/user/170074)



Photograph of Zosel Dam control room by Lars Uunila
Photographs of Zosel Dam from presentation by Brian Guy, Summit Environmental Consultants Inc.

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- Mike Cantwell, Lake Osoyoos Association
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- Anna Warwick Sears, Okanagan Basin Water Board
- Stu Wells, Mayor, Town of Osoyoos

A NOTE FROM THE AUTHORS

Our method for suggesting recommendations in this report was we, the authors, synthesizing our extensive notes, reviewing Forum presentation materials, reviewing Board of Control Plan of Study reports and bringing to bear our own experience in Okanagan water science and policy. The "suggested actions" found throughout this report are the informed perspectives of the authors, and they do not necessarily reflect the positions of the Forum Steering Committee or its associated institutions.

We believe the report is an accurate reflection of findings delivered at the Forum. Like the Forum content, our suggested actions cover a diversity of topics, with varying scope and implications. We have identified potential parties and institutions that could start the process of defining accountability for these suggested actions. These lists of responsible groups are not exhaustive. We have further tried to assess the level of consensus for these actions amongst the audience that participated at the Forum.

Any errors in approximating the level of agreement are that of the authors, not the Forum Steering Committee or its associated institutions.

Finally, photos and images used throughout section 2 were obtained from the various presenter presentations delivered at the Forum.

About Us

Clint Alexander is an integration specialist focused on decision and trade-off analysis methods for aquatic resource management problems. Focal areas include trade-off evaluations for reservoir operations, climate change adaptation, water budget studies and large-scale watershed restoration programs in Western North America. Many of his projects involve technical facilitation and the development of computer tools, such as the Premier's Award winning Okanagan Fish/Water Management Tool, and the Sacramento River Ecological Flows Tool. Clint has over 14 years of consulting experience with ESSA Technologies Ltd, where he is a managing partner and leader of the Fisheries and Aquatic Sciences Team. He holds a B.Sc. in Ecology from the University of British Columbia and a Masters in Resource and Environmental Management from Simon Fraser University.

Kellie Garcia has a degree and diploma in Environmental Science and more than nine years experience and training in the environmental field. She specialises in assisting multi-stakeholder committees with the preparation of management plans, sustainability documents, and best management practices guides. In 2005-06, she coordinated the 26-member volunteer advisory forum for the Cowichan Basin Water Management Plan project, co-authored the management plan, and assisted with the public outreach and consultation program. In 2008, she was the lead technical writer who worked with the Okanagan Water Stewardship Council to produce the Okanagan Sustainable Water Strategy. Kellie is currently the project manager for the BC Sustainable Winegrowing Program and works closely with a volunteer committee of wine grape growers, winemakers and winery hospitality managers to develop and implement the program. Ms. Garcia is a strategic thinker with a proven ability to translate ideas into clear, concise and effective strategies and programs.

EXECUTIVE SUMMARY

The second bi-national Osoyoos Lake Water Science Forum was held September 18-20, 2011 in Osoyoos, British Columbia. The goal of the Forum was to *provide a communication bridge for all levels of government and the public aimed at learning, sharing and developing strategies to work together to improve Osoyoos Lake and promote its future sustainability*.

Approximately 160 participants attended the Forum. About half of the participants were local citizens from communities in the region. Other participants included government officials, not-for-profit association members, Osoyoos Indian Band members and other Tribal representatives, and independent and government scientists. Approximately 115 of the participants were from Canada and 45 from the United States.

Osoyoos Lake is a microcosm of Columbia Basin water concerns. Osoyoos Lake spans the Canada – United States border in the Okanagan River basin, and has a wide array of challenges related to water resource sustainability.

The water level in Osoyoos Lake is primarily controlled by Zosel Dam, located in Oroville, Washington. The current International Joint Commission (IJC) Order of Approval that governs the operation of Zosel Dam terminates in 2013. The IJC used the Forum as an opportunity to gain input from stakeholders about issues and demands associated with Osoyoos Lake water levels. A local management board of the IJC, the International Osoyoos Lake Board of Control (Board of Control) administers the Operating Orders. The Board of Control commissioned eight studies to help develop the next Orders for Zosel Dam (referred to as the Plan of Study) and the results and recommendations of these studies were presented at the Forum.

The Forum also provided science updates on the broader needs for the ecological health of Osoyoos Lake. Many important water-related topics of our time were addressed at the 2011 OLWSF, including water shortages, floods, climate change, indigenous rights, fisheries concerns, water quality threats, and the recovery of species of risk.

This summary report provides an overview of the key findings made on these topics by presenters and panellists and the recommended next steps and actions (Section 2.0). The report is organized into 6 categories: climate variation and change, water quantity, water quality, fisheries and species at risk, conservation and governance, and land use planning. In total, forty-one (41) recommendations are made in this report.

A progress update on the twenty-six actions and steps for further scientific investigation that emerged from the inaugural 2007 Forum is provided in Section 3.0 of the report. Twenty of the actions identified during the 2007 Forum are rated as having Fair/Good to Excellent progress (77%). Though there has been considerable progress, the bulk of remaining work is in areas related to water quantity management and ecological and endangered species rehabilitation/protection.

Reflections by the report authors on the renewal of the IJC Operating Orders for Zosel Dam, including a history of Zosel Dam and the Orders, information about the Cooperation Plan between BC and Washington State, and an overview of the timeline and process for renewal of the Orders are provided in Section 4.0 of the report.

Three key themes emerged from the information and recommendations made by IJC Plan of Study authors, presenters, panellists, and audience members (see Section 4.4). These themes are closely interrelated, and provide a set of important guidelines for the IJC and Board of Control to take into account as they structure decisions heading into 2013.

THEME 1:

Create opportunities for success: acknowledge both the need for a broader scope of bilateral activities and the existence of constraints.

A recurring theme from the Forum, and from the IJC Plan of Study reports, is that the current Board of Control mandate leaves a number of important aspects of the health of Osoyoos Lake unresolved. There was much discussion among participants about whether the representation of the Board of Control could be expanded to include First Nations and other local representatives. Suggested alternatives included making the Board larger, or forming and linking with external committees/advisory bodies.

Just as the IJC's mandate and membership should be reviewed, so too should the profile of constraints on what is possible. The authors of IJC Studies 1, 2 and 3 all emphasized that Osoyoos Lake has limited regulated storage capacity and lake levels are constrained by the available inflow, which is almost completely dictated by the releases from Okanagan Lake (not Zosel Dam operations). Acknowledgment in the Orders of the importance of downstream flow needs, as well as the hydrologic constraints to realize these targets, will help catalyze new opportunities for success.

THEME 2:
Enhance cooperation while respecting sovereignty.

The IJC has not included downstream flow targets as firm 'rules' within the IJC Operating Orders, because increasing downstream flow would require increasing water deliveries from Okanagan Lake Dam in Canada. Instead, the non-binding BC – Washington Cooperation Plan contains minimum transboundary flow guidelines that both governments attempt to meet each year. The Province of BC supports the flows and procedures of the Cooperation Plan procedures as far as practicable.

IJC Plan of Study authors, Forum presenters and panellists generally supported the need for enhanced cooperation between British Columbia and Washington to balance flow needs downstream of Zosel Dam while respecting goals for Osoyoos Lake elevations and limits on releases that are possible from Okanagan Lake Dam. While there continue to be good reasons to avoid *binding* terms, the benefits of flexible mechanisms would be further aided by reference to these opportunities in the renewed IJC Operating Orders.

THEME 3:
Flexibly balance trade-offs using and supporting the best tools and science.

Trade-offs commonly occur when operating a dam for multiple objectives. Water levels in Osoyoos Lake, for example, are desired to be high in the summer to store water for irrigation and for instream flow purposes downstream of Zosel Dam. High levels are preferred by boaters and other recreational users; however, high levels cover the beaches and restrict areas for sunbathing and playing, and increase erosion from storms and boat wakes, affecting lakeside properties.

Numerous authors of IJC Plan of Study reports emphasized the need for greater flexibility in IJC Operating Orders to balance trade-offs, pointing out that even within a single objective, there is often no win-win scenario. Fortunately, water management in the Okanagan has seen a surge in basic water science and tools over the past decade. Capitalizing on this science by increasing disciplinary integration and extending science products into practical decision support tools will improve multi-disciplinary cooperation necessary to find suitable compromises.

Greater flexibility is also critical to adjust to surprises, new knowledge, and ongoing changes in climate. The renewed Orders should acknowledge the need for adaptive management, and the best science, tools, and knowledge.

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LIST OF ACRONYMS

BC	British Columbia
CCT	Colville Confederated Tribes
cfs	Cubic feet per second (water discharge)
COBTWG	Canadian Okanagan Basin Technical Working Group
DFO	Fisheries and Oceans Canada
DoE	(Washington State) Department of Ecology
EC	Environment Canada
FIM	Foreshore Inventory Mapping
FWMT	Fish Water Management Tool
IJC	International Joint Commission
IJC-PS	International Joint Commission Plan of Study
Board of Control	International Osoyoos Lake Board of Control
LOA	Lake Osoyoos Association
MoE	Ministry of Environment
NGO	Non-governmental organization
OBWB	Okanagan Basin Water Board
OLWQS	Osoyoos Lake Water Quality Society
OLWSF	Osoyoos Lake Water Science Forum
ONA	Okanagan Nation Alliance
OSHIP	The Okanogan Subbasin Habitat Improvement Project
RDCO	Regional District of Central Okanagan
RDOS	Regional District of Okanagan Similkameen
RMRM	Rocky Mountain ridged mussel
RPA	Recovery Potential Assessment
UBC Okanagan	University of British Columbia Okanagan
US	United States
USGS	United States Geological Service
WSC	Water Survey Canada

1.0 OSOYOOS LAKE WATER SCIENCE FORUM BACKGROUND

The second bi-national Osoyoos Lake Water Science Forum (OLWSF or "Forum") was held September 18-20, 2011 in Osoyoos, British Columbia. The Town of Osoyoos and the Okanagan Basin Water Board – working with local, state, provincial and federal organizations and the International Joint Commission – organized the Forum to focus attention on the need to sustain the health of the Osoyoos Lake and the well-being of residents and visitors.

Osoyoos Lake is a microcosm of Columbia Basin water concerns. The lake spans the Canada – United States border in the Okanagan River basin, and has a wide array of challenges related to water resource sustainability. The water level in Osoyoos Lake is primarily controlled by Zosel Dam, located in Oroville, Washington. The International Joint Commission (IJC) issued Orders of Approval in 1987 for maintaining a range of lake levels primarily for the benefit of agriculture, fisheries and recreation. The Order terminates in 2013 and the IJC will decide whether to renew or modify the Order at that time.

The impetus for the 2011 OLWSF was to share American and Canadian perspectives on the upcoming renewal of the IJC Osoyoos Lake Operating Orders for Zosel Dam. The IJC used the Forum as an opportunity to gain input from stakeholders about issues and demands associated with Osoyoos Lake water levels. The International Osoyoos Lake Board of Control (Board of Control) commissioned eight studies to help it develop the next Orders for Zosel Dam (referred to as the Plan of Study) and the results and recommendations of these studies were presented at the Forum.

The Forum also provided science updates on the broader needs for the ecological health of Osoyoos Lake and checked in on progress made since the inaugural 2007 OLWSF. Many of the most important water-related topics of our time were addressed at the 2011 OLWSF, including water shortages, floods, Zosel Dam operations, climate change, indigenous rights and fisheries concerns, water quality threats, and the recovery of species of risk.

The Forum was attended by approximately 160 people from Canada and the United States. Thirty-one presentations and two panel discussions were held during the Forum. The Forum program, which includes speaker biographies and presentation abstracts, and presentations delivered at the Forum are available at www.obwb.ca/olwsf. Email addresses for presenters, panellists and moderators are included in Appendix A.

1.1 Goal of the Forum

The goal of the Forum was "*to provide a communication bridge for all levels of government and the public aimed at learning, sharing and developing strategies to work together to improve Osoyoos Lake and promote its future sustainability*."

The Forum provided an opportunity for dialogue between Canadian and American residents, scientists, planners, university students, First Nations, government officials and politicians. Audience input was a very important component of the Forum. Input was collected using three methods:

1. A question and answer period after each presentation.
2. Two panel sessions with experts on water science and governance to take audience questions and comments.
3. Drop boxes for participants to provide written questions and views. These questions were delivered to panellists during panel discussions.

1.2 Participants

Approximately 160 registered participants attended the Forum. Participants included residents from Osoyoos, Oroville and other areas, government officials, not-for-profit association members, Osoyoos Indian Band members, and independent and government scientists. Approximately 115 of the participants were from Canada and 45 from the United States.

1.3 Focus and Organization of this Report

The authors of this report have synthesized information and dialogue from the Forum, focusing on take-home messages and next step actions.

The report is organized as follows:

- Section 2 organizes the ideas and insights from Forum presenters and panellists in six categories, and provides a brief overview of questions and comments from the audience, and a list of suggested actions and next steps. Readers are presented with one or two selected slides from presentations delivered during the Forum. See www.obwb.ca/olwsf for complete presentation material.
- Section 3 provides a summary of progress made on actions identified at the 2007 Forum.
- Section 4 includes reflections on the renewal of the Osoyoos Lake Operating Order for Zosel Dam.
- Section 5 contains a summary of actions and next steps.
- Section 6 provides a consolidated list of agencies involved in water management activities.
- Section 7 lists literature cited and suggests further reading.
- Appendix A is an email directory of presenters, panellists and moderators.
- Appendix B contains the 1982 Order for Zosel Dam.

Results and recommendations of the eight IJC studies are highlighted in boxes throughout the report.

Forum presentations, panel discussions, and audience questions and feedback are arranged in six categories:

- Section 2.1 - Climate Variation and Change
- Section 2.2 - Water Quantity
- Section 2.3 - Water Quality
- Section 2.4 - Fisheries and Species at Risk
- Section 2.5 - Conservation and Governance
- Section 2.6 - Land Use Planning

2.0 OVERVIEW OF PRESENTATIONS, PANEL DISCUSSIONS AND AUDIENCE FEEDBACK

This section summarizes ideas and insights from Forum presenters and panellists[1] provides an overview of audience questions and comments, and lists recommended actions and next steps.

2.1 Climate Variation and Change

2.1.1 Key points made by presenters and panellists

Okanagan Basin Climate Studies

Dr. Denise Neilsen, Research Scientist, Pacific Agricultural Research Centre

A 500m x 500m gridded climate data set is used to predict climate change in the Okanagan. It interpolates daily minimum and maximum air temperature and precipitation from weather station data and takes into account latitude, elevation, and distance to major lakes.

The gridded data is analysed based on six Global Climate Model outputs 1961-2100 with two greenhouse gas emissions scenarios, statistically downscaled to meet regional needs. Grid cell calculations and other indices are also taken into account. Dr. Neilsen highlighted the numerous applications of these data sets: lake evaporation studies, surface water hydrology modelling, studies of water demand, growing degree day models for use in crop studies, etc.

There is increasingly sparse local Okanagan basin weather data to characterize climatic variation, especially at higher elevations. In light of this constraint, new methods are being developed to characterize climatic variation. However, all methods require real observational data and the gradual reduction in weather stations in the basin represents a threat to advancements in local climate modelling tools.

Climate change projections for the Okanagan (under the high greenhouse gas emissions scenario) include:

- Slight increase or little change in amount of precipitation, but the form (snow/rain) and timing may change.
- Gradual increase in highest and lowest temperatures - implications for crop suitability, ecosystems, and vegetation and insect survival.
- Potential increase in frost free days - longer growing season.
- Potential increase in growing degree days with implications for invasive species and crop suitability (e.g. wine production may be moving from premium to something less desirable).
- Possible increase in potential evapotranspiration. Lower actual evapotranspiration, resulting in water limitations in natural ecosystems and a change in vegetation.
- Decrease in snowpack and earlier snowmelt.
- Gradual increase in annual irrigation demand.

"We are dealing with a very complex system that is already degraded. There are large uncertainties associated with climate change, population growth and water use. Tools contribute to our knowledge but there are many data gaps. We need mechanisms to react to changes and prevent further degradation."

Dr. Denise Neilsen, Agriculture and Agri-Food Canada

[1] Panellist quotes are included in *italic text*.

IJC Plan of Study 6:
Climate Change and its Implications for Managing Water Levels in Osoyoos Lake

Dr. Brian Guy, Senior Geoscientist, Summit Environmental Consultants

Citing research from the Pacific Climate Impacts Consortium (PCIC) and the Okanagan Water Supply and Demand Project, the authors of Study 6 highlighted the general agreement amongst future climate models for the South Okanagan. These sophisticated models generally agree on the following hydrologic changes resulting from climate change:

- Earlier start to the spring runoff (larger proportion of freshet runoff prior to Apr 1).
- Lower runoff in spring (after Apr 1) and late summer/fall.
- Higher runoff in winter with increased precipitation, and greater proportion as rain (i.e. less snow storage and therefore less ability to capture precipitation for later in the season).
- Slight increase in annual runoff.
- Small changes in daily peak flows (slightly lower).
- More water withdrawn from Osoyoos Lake (11% more by mid-20s; 22% more by mid-50s).
- More lake evaporation.
- More frequent drought declarations in future.

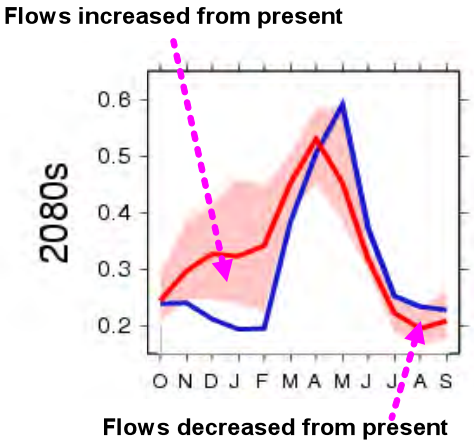


Figure 2.1: Typical flow pattern for many areas in Pacific Northwest under climate change (2080s). **Red** line represents the average of a series of climate models. **Blue** line represents historical average.

Table 2.1: Summary of future climate changes on key variables for South Okanagan - Similkameen. GDD = growing degree days. FFD = frost free days. Source: University of Victoria PCIC Plan2Adapt Tool.

Climate Variable	Time of Year	Projected Change (from 1961-1990 baseline)		
		2020s	2050s	2080s
Mean Air Temp. (°C)	Annual	+1.1°C	+1.9°C	+3.0°C
Precip.	Annual Summer Winter	+4% -9% +2%	+6% -14% +6%	+8% -16% +10%
Snow depth	Winter Spring	-6% -33%	-14% -57%	-22% -78%
GDD	Annual	+175	+379	+571
FFD	Annual	+15	+26	+39

2.1.2 Focus of audience interest and feedback

Audience questions and comments focused on whether there have been efforts to include data on the US portion of the Okanagan Basin in climate studies, what impact climate change will have on food crops in the Okanagan, and whether financial assistance is available for water storage projects to deal with the impacts of climate change. An audience member also asked if affected property owners would be compensated when the Zosel Dam is operated in drought mode and a heavy rain comes that inundates their properties for an extended period of time.

2.1.3 Recommended next steps and suggested actions

- Suggested Action 2.1.1 ***Increase the number of weather stations in the Okanagan Basin, especially at higher elevations***.

  Who: Province of BC and Environment Canada (EC), in partnership with local governments

- IJC-PS 6 Recommendation 1 ***If*** *the IJC deem it necessary to employ a drought declaration, allow droughts to be declared earlier in the spring* (e.g. March 1 instead of April 1) because of a projected earlier runoff in spring.

  Who: Board of Control on behalf of IJC

- IJC-PS 6 Recommendation 2 ***Allow more flexibility in filling Osoyoos Lake***. Increased flows are projected through winter and freshet is projected to begin earlier. Earlier storage may be required to take advantage of the available water.

  Who: Board of Control on behalf of IJC

- IJC-PS 6 Recommendation 3 ***Allow gradual changes in lake level (known as "ramping") over a defined period as opposed to setting strict date-specific water level requirements***. This will provide flexibility, which is particularly important given the wide range of projections for future water supply.

  Who: Board of Control on behalf of IJC

- IJC-PS 6 Recommendation 4 ***Reconsider whether a distinction between drought and non-drought conditions is even required.*** *In its place, a flexible lake management strategy that applies to all years could be developed.*

  Who: Board of Control on behalf of IJC

- IJC-PS 6 Recommendation 5 ***Evaluate the suitability of using fixed-dates for the summer and winter operating ranges in light of the projected future advance of the spring lake inflows.***

  Who: Board of Control on behalf of IJC

- IJC-PS 6 Recommendation 6 ***Incorporate adaptive management principles and strategy to evaluate the performance of the revised Orders, with a view to periodically modify and refine them.*** This is particularly important since there is a range in projected future conditions and fixed rules inherently assume a static future.

  Who: Board of Control on behalf of IJC

2.2 Water Quantity

2.2.1 Key points made by presenters and panellists

Water Supply and Demand Project

Dr. Anna Warwick Sears, Executive Director, Okanagan Basin Water Board

The Phase 2 Water Supply and Demand Project (the "Project") included an extensive series of studies looking at current supply and demand in the Okanagan using an integrated hydrologic studies and computer models, including a basin wide water accounting model. Future scenarios were also conducted as part of the Project and included climate change, land use, population growth and drought parameters (see: www.obwb.ca/wsd).

Study results show that of our incoming precipitation, 80% goes back to the atmosphere through evapotranspiration and evaporation, 7% goes to aquifer recharge, and 13% goes to surface flows.

Our peak water use is during the summer. 86% of our current water use is for irrigation, with 55% of that irrigation water going to agriculture and 25% to residential landscaping (the remainder is for parks/open space, golf courses and industrial/commercial uses).

Future climate scenarios suggest little change in *average annual* precipitation but that more will come in the form of rain than snow (Figure 2.2). The timing of water supplies is the most significant future change, with a decrease expected in summer flows in Okanagan creeks. Dr. Warwick Sears also emphasized that we have limited upland reservoir space and not much room to expand so we need to work within our budget or risk "mining" Okanagan Lake to unacceptably low elevations.

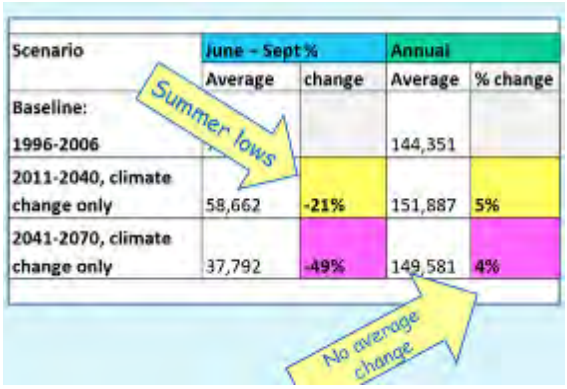


Figure 2.2: Projected seasonal flow changes in Mission Creek.

Future Project scenarios also show that if we continue with our current trend of high water demand, urban sprawl, and full irrigation we will potentially see a spike in water use even with efficiencies. We need to think a lot about where and how development is happening and what kind of landscaping people use.

Ongoing updates to the Project include:

- Okanagan Lake evaporation study underway by Environment Canada.
- Hydrological Connectivity Study and additional future climate scenario modeling.
- Okanagan Water Viewer (www.okanaganwater.ca).
- Local Government User Guide.

Okanagan Basin Hydrological Connectivity Study

Nelson Jatel, Water Stewardship Director, Okanagan Basin Water Board

A study is being conducted by the Okanagan Basin Water Board to investigate how water supply utilities are hydrologically connected in the valley, how that connectivity impacts reservoir storage, and how downstream users and licences are affected by upstream users and licences under the current "first in time, first in right" (FITFIR) water allocation approach.

Mr. Jatel illustrated a large number of ways in which hydrologic connectivity affects local government decision-making, including risk

management and legal liability procedures, emergency planning, municipal infrastructure decisions, need for new drought plans, policies, bylaws, codes and procedures, and funding and grant opportunities.

The majority of water is supplied by 21 water purveyors, which extract water from 12 tributaries plus the valley lakes and Okanagan River.

Several tools and models were used to support the Connectivity Study, including the Water Evaluation and Planning system (WEAP). The Okanagan hydrologic connectivity WEAP model shows where water utilities are located in the Basin and how their licences may be affected under different water supply and demand scenarios according to the FITFIR approach. Decision support tools developed under the Connectivity Study will support the science foundation for developing drought plans and exploring the implications of other water allocation systems, including trade-offs between ecological flow needs and human water uses.

"We need to simplify access to complex science so it can be used by resource managers and policy makers. We need to be able to put science to work on the ground right away by providing synthesized information and decision support tools that show the way ahead."

Dr. Kim Hyatt, Fisheries and Oceans Canada

IJC Plan of Study 1: An Assessment of the Most Suitable Water Levels for Osoyoos Lake

Dr. Michael Barber, Professor, Washington State University

The focus of IJC Plan of Study 1 was to examine the projected 2040 water demand from Osoyoos Lake and explore ranges of lake elevations that could potentially be used to meet the demand. The Study examined whether it would be necessary to modify the specifications of the existing Order of Approval when it comes up for renewal to help meet the projected demand.

In summarizing the main findings of IJC Plan of Study 1, Dr. Barber emphasized the following:

- Study 1 authors did not identify a significant difference between current and 2040 water demand on Osoyoos Lake[2].
- Residential, commercial and municipal demands are small relative to preferred instream/fisheries flow and agricultural water demands.
- Optimum preferred instream fisheries flows account 90% of the total demand.
- Upstream inflows are the primary water supply to Osoyoos Lake, which has limited regulated storage capacity.
- Future increases in demands will need to be met through increased supply from upstream sources and/or new supplies (e.g. Similkameen River).

[2] **Note**: external reviewers of IJC Study 1 have commented that the authors omitted consideration of climate change effects on water demand. The recently completed Okanagan Water Supply and Demand Project (www.obwb.ca/wsd/) illustrated that this effect is not negligible.

IJC Plan of Study 2: Evaluation of Criteria to Declare Drought and Study 3: Review of Dates for Summer and Winter Operation

Jim Mattison, Consultant, Urban Systems

Water levels on Osoyoos Lake are controlled by Zosel Dam in Washington State, and are managed in accordance with Orders of the IJC. Studies 2 and 3 were designed to provide information to the IJC Commissioners to consider in development of the renewed Orders for Osoyoos Lake in 2013. Study 2 is an evaluation of the criteria used to declare drought and Study 3 is a review of the dates for switching between summer and winter operation. Studies 2 and 3 help the Commissioners and their advisors determine the authorized water levels and the timing of those levels, whether summer or winter, drought or not.

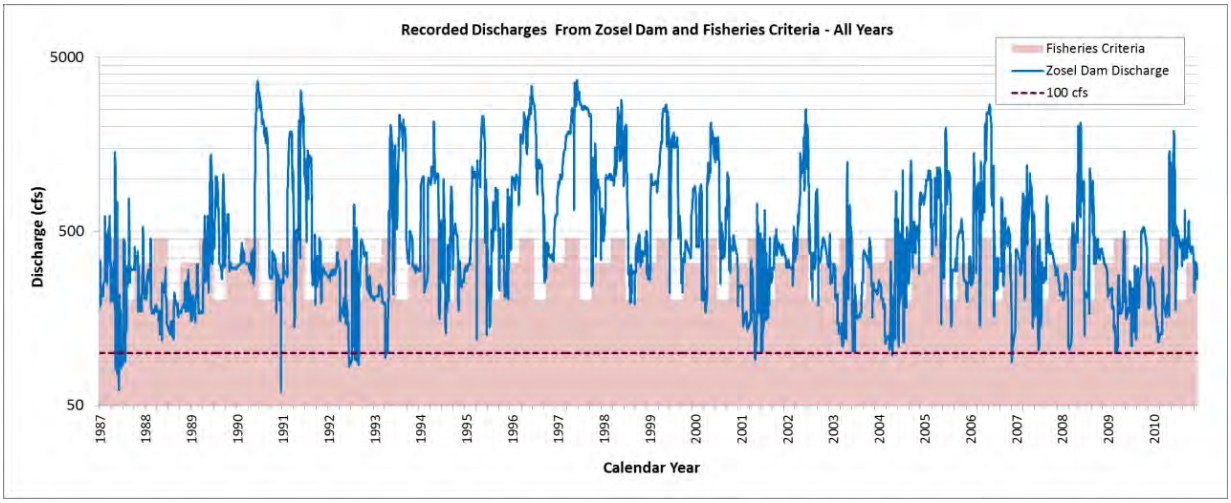


Figure 2.3: Historical Zosel Dam discharge relative to minimum recommended fish flow criteria, showing downstream fisheries flows frequently not being achieved, especially the years 2000 to 2010.

Some of the main findings of IJC Studies 2 and 3 were:

- The all or nothing, drought or not approach is not the optimum way to manage Osoyoos Lake elevations.
- The current drought declaration criteria are signalling drought more often than would be considered drought by common definition. Approximately 25% of March drought declarations are rescinded once updated inflow forecasts are provided a few weeks after the initial drought declaration.
- Raising Osoyoos Lake to reach the April 1 911.0 ft IJC target is not consistent with Okanagan Basin hydrology where the bulk of the freshet typically occurs in May and June. The current April 1 requirement therefore forces the Zosel Dam operator to try to raise the level of Osoyoos Lake when inflows are naturally low (to the detriment of downstream fish flows).
- Studies 2 and 3 also emphasized Osoyoos Lake levels are constrained by the available inflow, which is almost completely dictated by the releases from Okanagan Lake (not Zosel Dam operations).
- To meet recommended fisheries criteria, Osoyoos Lake levels would need to frequently be drawn down below 909.0 feet or additional storage considerations and releases from Okanagan Lake coordinated.

IJC Plan of Study 7:
Demonstration of Factors that Govern Osoyoos Lake Levels During High Water Periods

Dr. Brian Guy, Senior Geoscientist, Summit Environmental Consultants

IJC Plan of Study 7 examined the circumstances and factors responsible for Osoyoos Lake levels exceeding 911.5 feet, and the capabilities of Zosel Dam to mitigate high water levels. The Study also considered whether Zosel Dam could have been operated better since 1987 to reduce the frequency, magnitude, and duration of high Osoyoos Lake levels. Lake levels above 912.5 ft cause concern for the shoreline environment and structures.

The major findings of IJC Plan of Study 7 were:

- High Osoyoos Lake levels (> 912.5 ft) are caused by 1) Osoyoos Lake's small regulated storage volume, 2) high inflows from the Okanagan River (namely releases from Okanagan Lake Dam at Penticton), and 3) backwater from the Similkameen River when Similkameen flows exceed 10,000 cfs.
- Operators could have delayed the onset of high water levels (> 912.5 ft) by about a week, but they could *not* reduce the ultimate height reached (years 1990, 1991, 1996, 1997, 1999).
- In normal summers, lake levels exceed very high levels (913 feet) only 4% of the time.

IJC Plan of Study 8:
Review of Methods to Monitor Channel Capacity of the Okanogan River Downstream of Osoyoos Lake

Dr. Brian Guy, Senior Geoscientist, Summit Environmental Consultants

Condition 4 of the IJC Supplementary Order of Approval of 1985 requires that the flow capacity of the Okanogan River, upstream and downstream from Zosel Dam to pass at least 2,500 cubic feet per second without overbank flooding when the elevation of Osoyoos Lake is 913.0 feet and there is no appreciable backwater effect from the Similkameen River.

IJC Plan of Study 8 (Part 1) was commissioned to evaluate whether the Okanogan River downstream of Zosel Dam is able to safely transmit flow, and to consider what modifications may be needed to the monitoring program used to detect effects of sedimentation on the river's transmission ability.

IJC Plan of Study 8 confirmed the *overall* suitability of the monitoring program (with refinements):

- The system used to currently monitor the flow capacity of the Okanogan River upstream of the Zosel Dam involves three main components:

  1) Analysis of hydrometric records of Okanogan River and Osoyoos Lake to confirm that the river channel has the capacity to convey 2,500 cfs while Osoyoos Lake is at a level of 913 ft or lower. Flows and water levels sufficient to confirm capacity occurred in only eight (8) of the last 22 years.

  2) River channel geometry is surveyed at four (4) established cross sections near the outlet of Osoyoos Lake and near the mouth of Tonasket Creek at 10–year intervals, or if five (5) consecutive years pass without river flows sufficient to confirm channel capacity. This is done to detect changes in channel morphology (e.g. sedimentation).

  3) Modeling for the four surveyed cross sections.

2.2.2 Focus of audience interest and feedback

Audience questions and comments focused on improving data collection and reporting, policy around water ownership and transfer of water rights, defining agricultural and ecological water reserves, and the potential for increasing the regulation of water levels and flow in other areas of the Basin in addition to Zosel Dam (e.g. upstream supplies from Okanagan Lake and possible out-of-basin transfers from Similkameen River near Princeton).

2.2.3 Recommended next steps and suggested actions

- Suggested Action 2.2.1 ***Develop a basin wide drought plan***. This would include extending tools developed under the Okanagan Basin Water Supply and Demand Project and the Okanagan Hydrologic Connectivity Study (science foundation). The first phase of drought plan development should evaluate trade-offs among alternative water allocations. Included in the drought plan would be explicit treatment of instream ecological flow needs, as well as policy priorities such as an Agricultural Water Reserve.
  Who: Province of BC and local government partners, OBWB
- Suggested Action 2.2.2 *Increase collaborative research on remote sensing technology and increase the number of hydrometric monitoring stations to* ***improve water supply forecasting.***
  Who: Province of BC, Water Survey Canada (WSC), United States Geological Survey (USGS) and local government partners in the U.S. and Canada
- Suggested Action 2.2.3 ***Develop and fund additional demand management programs and (monetary) incentives for water saving technologies.***
  Who: Governments of Canada and the US, Province of BC, State of Washington, local governments
- IJC-PS 1 Recommendation 1 ***Structure IJC Operating Orders for Zosel Dam to consider flows and lake elevation targets within a system-wide water management frame***. Osoyoos Lake does not have the capacity to handle the kind of storage levels needed to address the expected deficits in demand during drought and half of normal years. The success of such a management strategy would depend on the ability to obtain estimated Osoyoos Lake inflows (i.e. primarily Okanagan Lake outflows) ahead of time.
  Who: Board of Control on behalf of IJC
- IJC-PS 1 Recommendation 2 Given its dominance on Osoyoos Lake demand, ***better accommodate instream/fisheries flow criteria in the renewed IJC Operating Orders***. Stakeholders concerned with fisheries and ecological demands downstream of Zosel Dam are less concerned about Osoyoos Lake elevation than the discharge amounts from the dam. Further, when defining and incorporating downstream ecological flow needs there is a need to better quantify the implications of not meeting all of these requirements and to develop "acceptable risk" flows in addition to preferred requirements.
  Who: Board of Control on behalf of IJC
- IJC-PS 1 Recommendation 3 ***During summer months*** in normal and drought years, ***manage Osoyoos Lake between 912 and 912.5 ft***. Erosion from boat wakes and wind driven waves is a problem above 912.5 ft. Otherwise, the Study 1 authors do not see a necessity in changing the current Order specifications related to Osoyoos Lake elevation management.
  Who: Board of Control on behalf of IJC
- IJC-PS 1 Recommendation 4 ***Improve research into alternative***

sources of water. For example, complete investigations of the feasibility of options such as the "Kruger Mountain" project, a 2-mile long tunnel from Shanker's Bend area on the Similkameen River to a discharge point near the US/Canada border designed to carry a flow of approximately 200 cfs.

Who: Board of Control on behalf of IJC

- IJC Studies 2&3 Recommendation 1 ***Eliminate the existing drought declaration and in the renewal Orders follow a single, flexible management regime applied for both normal and drought years***. Specifically, a target Osoyoos Lake level of 910 feet for the winter and 912 feet for the summer with a range of acceptable levels of +/- 0.5 feet. An eight-week window in the spring and fall would permit gradual raising and lowering of the lake levels with the spring period set for March 15 to May 15, and the fall lowering October 1 to December 1 (Figure 2.4). This has the advantage of providing more flexibility to meet multiple objectives. With respect to fisheries objectives, the implication is that there would be increased flows for fish available at critical times.

  Who: Board of Control on behalf of IJC

Figure 2.4: Recommended Osoyoos Lake elevation management plan (blue).

- IJC Studies 2&3 Recommendation 2 ***Incorporate ramping guidelines into future IJC Operating Plans for the Zosel Dam, namely downward ramping rates during periods of low flow between October 1 and March 1.*** Ramping can be determined according to general guidelines (e.g., no more than 1.5 inches per hour), as established by other fisheries agencies, or examined more closely through a study directed at the Okanogan River downstream of Zosel Dam. Critical elements of a future ramping rate study would include local information on river morphology, substrate composition, salmonid spawning and rearing habitat use, and timing.

  Who: Board of Control on behalf of IJC

- IJC Studies 2&3 Recommendation 3 ***Use the Standardized Precipitation Index (SPI) to indicate drought severity.*** SPI is the most commonly used index worldwide and has wide acceptance (GAR 2011). A drought event begins any time when the SPI is continuously negative and ends when the SPI becomes positive.

  Who: Board of Control on behalf of IJC

- IJC-PS 7 Recommendation 1 ***Increase coordination with operators of Okanagan Lake Dam at Penticton to improve control over high (and low) Osoyoos Lake levels.*** Washington DoE and BC MoE should extend initiatives and informal agreements related to Osoyoos Lake levels as affected by releases from Okanagan Lake Dam at Penticton.

  Who: Board of Control, BC MoE, Washington DoE

- IJC-PS 7 Recommendation 2 ***Under normal water supply conditions (i.e. a low risk of future drought), maintain Osoyoos Lake water levels near the lower limit of the specified operating range (911.0 ft).*** This will minimize the period of time for which the

lake is at risk of exceeding its target operating range in the summer period.

Who: Board of Control, Washington DoE

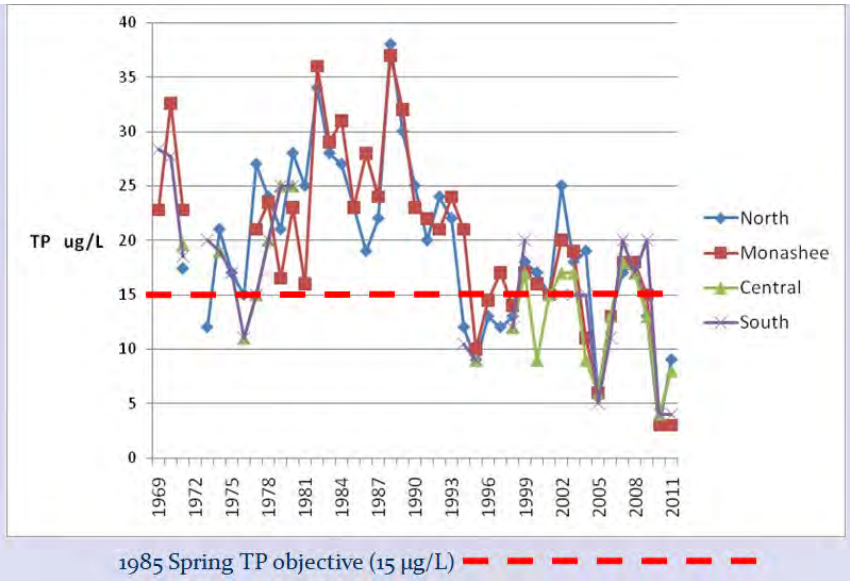
- IJC-PS 8 Recommendation 1 ***Continue monitoring Okanogan River downstream of Zosel Dam for sedimentation and other risks that may affect its ability to safely transmit flow.*** See Study 8 for a list of specific monitoring design refinements.

  Who: Board of Control on behalf of IJC

Water quality objectives are targets set for a waterbody based on BC Water Quality Guidelines. They are not legally binding, but can be used to guide liquid waste management planning and the issuance of permits and licences, and provide a reference against which the state of water quality can be checked.

Objectives are set by considering how local water quality variation is influenced and are based on best available science, professional judgement and public expectations.

An objective for Osoyoos Lake total phosphorus (TP) level was set in 1985 at 15 ug/L (or ppb). An assessment of the objective was recently conducted in light of new data on sources, historical trends and seasonal patterns.



Sources include external upstream point sources and internal surface and deep water phosphorus.

Figure 2.5: Long-term trend in Osoyoos Lake total spring phosphorous relative to the 15 ug/L objective used by the Province of BC.

Summary of phosphorus loading in Osoyoos Lake:

- Long term monitoring shows significant reductions since the late 1980s, primarily due to reduction of sewage inputs from Penticton and Oliver.
- Concentrations of phosphorous still periodically exceed the 15 ug/L guideline. Wet years see an increase in spring total phosphorus (TP); load is primarily driven by inputs from the Okanagan River upstream of Osoyoos (lagged nearly 1 year).
- Multiple diffuse nutrient sources (e.g. septic fields and agricultural activities) have an impact Osoyoos Lake water quality.

2.3 Water Quality

2.3.1 Key points made by presenters and panellists

An Update of the Osoyoos Lake Water Quality Objectives: Reference Points for Water Resource Management

Vic Jensen, Ministry of Environment

- A sediment core from the north basin (approximately 220 years old) shows phosphorus levels of (~ 17 to 19 µg/L) before European settlement (Figure 2.6). Hence, Osoyoos Lake is naturally mesotrophic over the past ~200 years. Osoyoos Lake spring TP 2000-2010 ~ 14 µg/L, and hence, current TP concentrations are similar to pre-settlement levels.
- There is still room for improved lake water clarity, decreased frequency of algal blooms.

Mr. Jensen stated one conclusion of the review is that the existing spring total phosphorus objective of 15 ug/L is still appropriate, especially in normal/below normal water years. This objective should not be expected to be met in wet years when upstream TP loadings are high.

Emerging issues such as pharmaceuticals and other organic chemicals have become a relatively higher priority in terms of risks to water quality and aquatic ecosystems.

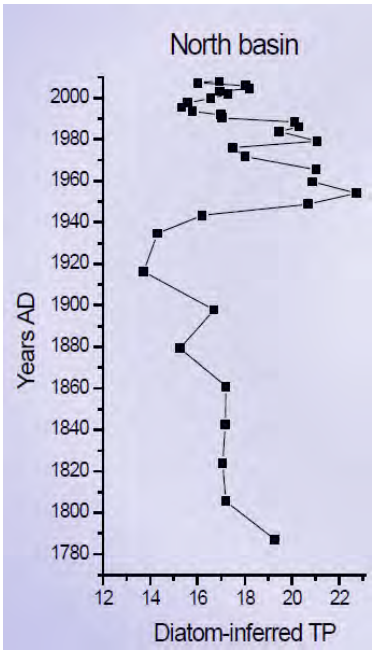


Figure 2.6: Pre-settlement diatom inferred Osoyoos Lake total phosphorous (ug/L) based on sediment core analysis.

Estrogen and Waste Water Treatment: Recent Findings and Next Steps

Dr. Jeff Curtis, Head of Chemistry & Earth and Environmental Sciences, UBC Okanagan

A study completed by UBC Okanagan researchers measured estrogen levels in effluent and receiving waters and calculated degradation rates in receiving waters. Grab samples were taken monthly from treated wastewater effluent at Vernon, Kelowna, and Penticton treatment plants and from receiving waters at MacKay reservoir in Vernon, Okanagan Lake in Kelowna, and Okanagan River in Penticton. Total estrogens in wastewater treatment effluents were higher in Kelowna, and about the same in Penticton and Vernon. Estrogens were detected in MacKay Reservoir and Okanagan River, but not in Okanagan Lake.

Conclusions of the study include:

- Wastewater treatment plants are releasing estrogens.
- There are environmental mechanisms that can reduce estrogens in receiving waters (microbial degradation).
- In a reservoir environment, it takes about 100 days for these compounds to degrade by 50% and further polishing occurs through groundwater infiltration and then dilution.
- Multiple levels of treatment are optimal to cleanup estrogens.
- Rivers provide less dilution volume and lower residence time for polishing of estrogens out of wastewater.
- Numbers indicate concentrations in receiving waters are negligible for human consumption but very little research for chronic low dose exposure outcomes.

Table 2.2: Estrogen concentration results for sample sites (receiving waters, not effluents) used in the UBC Okanagan Estrogens Project.

Site	Total EDC (ng/L)
MacKay Reservoir	0.3-1.3
Vernon tail-waters	Non-detectable
Okanagan Lake	Non-detectable
Okanagan River	<0.07-0.4

Extremely low concentrations of estrogens are known to cause serious disruption of reproductive capabilities in fish populations (e.g., 5ng L^{-1} Estradiol caused total collapse of fish population (Kidd et al. 2007))[3]. The British Columbia Ministry of Environment guideline for ethinylestradiol: *"30-d average concentration should not exceed 0.5 ng L^{-1} with no single value to exceed 0.75 ng L^{-1}"*.

A new study is currently being conducted to see whether levels in MacKay Reservoir are sufficient to induce responses in aquatic organisms (using goldfish).

"Science is in all different stages but it is happening throughout the Okanagan. We need to take pride in accomplishments in past science. Osoyoos Lake water quality has improved due to our efforts."

Dr. Jeff Curtis, UBC Okanagan.

Groundwater Resources in Osoyoos

Sean Fleming, Senior Hydrologist, Environment Canada

Groundwater is important because it is a major water supply source, it influences surface water hydrology and it can provide a potential pathway for contaminants to rivers and lakes.

The Osoyoos west aquifer is classified as moderate development and high vulnerability. It is a transboundary aquifer with a hydraulic connection to Osoyoos Lake.

- IIA classification: moderate development, high vulnerability
- Transboundary aquifer; hydraulic link to transboundary lake

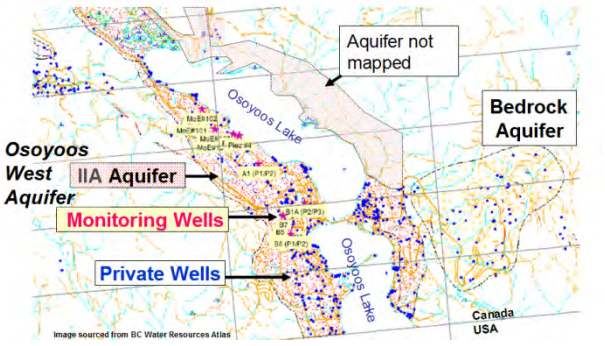


Figure 2.7: Location of Osoyoos West aquifer and presence of unmapped aquifer on East side of Osoyoos Lake.

Research shows that the seasonal groundwater peak lags behind weather and surface water changes; the average peak is in mid-to-late summer. The changes to groundwater levels overall are negligible or mixed but with a weak tendency for declines over time.

The Osoyoos west aquifer has experienced elevated nitrate concentrations over time. The results have varied across the aquifer from approximately 0 to 2 times the 10 mg/L drinking water guideline.

The groundwater flow direction is to the lake so there is concern that the groundwater could carry nitrates to the surface water and contribute to eutrophication.

A study showed that the predominant nitrate source in the aquifer is chemical fertilizers. Osoyoos west groundwater is shallow and recharge is from irrigation return flow in irrigation areas or precipitation in non-irrigated areas.

Data does not show a strong and clear seasonal pattern or change of nitrates levels over time; there is a year to year variation but no clear trend up or down.

The nitrate levels in some wells vary in sync with each other, but some do not and others even trend in the opposite direction. These results suggest complex nitrate dynamics.

Knowledge gaps include:

- Detailed shallow groundwater flow patterns and surface water-groundwater interactions, including seepage rates and nitrate loadings to Osoyoos Lake.
- Mountain recharge and deep/bedrock groundwater flow patterns.
- Groundwater level and chemistry conditions and trends on the east side of Osoyoos Lake.
- Occurrence of other potential groundwater contaminants.
- Past lapses in field sampling: contribute to uncertainties in trends/patterns in water levels and, in particular, nitrate concentrations.

[3] One ng/L is equivalent to one part per trillion. This is equivalent to one-twentieth of a drop of water diluted into an Olympic-size swimming pool.

"When I arrived to the Okanogan in 1996, the eastern side of Osoyoos Lake wasn't developed. I wonder what the groundwater levels are now compared to 1996 and what they will be in 10 years. Also what are the potential impacts of invasive species? We need to take better notice of threats further than just upstream and along the shoreline."

Chris Fisher, Colville Confederated Tribes

Osoyoos Lake Northwest Sewer Project

Phil Armstrong, Planning Technician, Town of Osoyoos

The Osoyoos Lake Northwest Sewer Project involves installing over 9 km of sewer line to deal with contamination issues associated with small lots and septic fields in the northwest sector of Osoyoos. The project has a long history that dates back to the 1980s. Construction will begin in 2012.

The system includes 130 NW sector properties, 40 lots at Willow Beach and 22 lots at Reflection Point.

The Town of Osoyoos and the Regional District of Okanagan-Similkameen (RDOS) joined forces to make the project a reality. The Town of Osoyoos committed to build, operate and maintain the system, and the RDOS created a service area for those not willing to pay the hook-up fee upfront.

The project's total cost was $6.4 million, shared between Willow Beach and Reflections Point ($1.1 million), grants to the Town of Osoyoos ($4.3 million), and NW properties ($1 million).

Lessons learned included:

- Understand the principles behind the service, in this case it is to protect lake quality.
- Know your clients, in this case they included existing and new development.
- Know the timeframes and regulations governing your partners.
- Effective communications is key.
- Right of way acquisition can be tricky but is very important.
- Approvals and permits take time and can be difficult to acquire.

The Value and Function of Natural and Constructed Wetlands

Curt Kerns, President, Wetlands Pacific Corporation

North America once had vast areas of wetlands associated with virtually every stream, river and lake. Runoff was filtered by sod, woodlands and wetlands and particulate and dissolved nutrients were retained on land or were mineralized.

Today, more than 50% of wetlands have been lost to agriculture, settlements, and roads. Wastewaters are no longer filtered through natural systems. Complex nutrients are released into our storm, urban and agricultural wastewaters and toxic algae blooms are more common.

Wetlands remove and detoxify substances, act as nutrient and carbon sinks, sequester heavy metals, slow water release from storm events, recharge aquifers, and provide vital wildlife habitat.

Wastewater treatment includes: primary treatment – lots of bang for the buck, secondary treatment – more difficult but can still get 95%, tertiary treatment – hard to remove the last 5%.

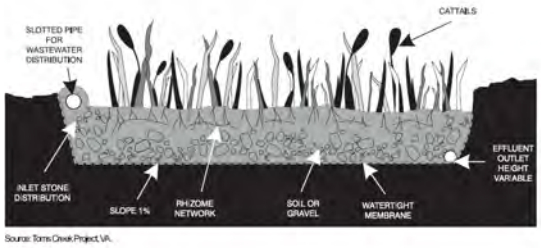


Figure 2.8: Schematic of a constructed wetland used for treatment of wastewater/greywater and other ecosystem services.

Figure 2.9: Example of a linear constructed wetland.

Constructed wetlands are a series of shallow ponds intended to remove contaminants. They are created by humans and often occur where enlightened citizenry, political pressure and wastewaters co-exist. They are used for stormwater, municipal wastewater, landfill leachate, agricultural runoff, acid mine drainage and industrial and commercial wastewaters.

Osoyoos Lake Milfoil Control by the Okanagan Basin Water Board

Dave Caswell, OBWB Milfoil Control Program

The invasive Eurasian watermilfoil (*Myriophyllum spicatum*) was first identified in Okanagan Lake in 1970. Milfoil forms dense weed beds, reducing habitat for native plants and limiting light penetration and water flow, and increases sedimentation. It is also a nuisance and hazard to boaters, swimmers, anglers, and waterfront property owners.

Past control methods in the Okanagan included herbicide application in 1981 (2-4D) on a trial basis (short-lived as this effort faced enormous public outcry), diver hand removal and bottom barrier application (only a short-term solution), jetting and dredging, screens in the Okanagan River channel, and boat inspection and wash stations.

Current methods include using rototillers during winter and harvesters in summer (Figure 2.10) to mow plants to a depth of about 3 metres.

New technologies are being used to improve operations, including using GPS to conduct aquatic plant surveys and Geographical Information Systems maps to monitor work sites year to year.

Figure 2.10: A harvester is used to mow watermilfoil plants in the Okanagan Valley mainstem lakes in the summer.

Milfoil control crews work within timing windows to protect species during vulnerable portions of their life-cycle and to avoid sensitive habitats.

New methods are also being explored, including biological control using the milfoil weevil, and low-impact (but highly labour intensive) hand removal by dive teams (Figure 2.11). The results of a summer pilot program indicated the milfoil weevil is a native species in Christina Lake and that a population augmentation program may be effective in managing large areas of infestation.

Figure 2.11: Hand removal by dive teams and biological control are new watermilfoil management methods being explored in the Okanagan Basin.

The Rocky Mountain ridged mussel (RMRM) is an emerging species of concern that is now being considered in milfoil management practices. RMRM was designated by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as Endangered in November 2010. RMRM is presently restricted to the Okanagan Basin with small aggregations present in the northeast and southwest areas of Okanagan Lake, in addition to a few individuals encountered in Vaseux Lake and the Okanagan River. The Department of Fisheries and Oceans Science branch has been asked to undertake a Recovery Potential Assessment (RPA). Potential or known threats and their impacts to habitat such as channelization of the Okanagan River, dams and weirs, development of shoreline and littoral zones, pollutants and introduced species such as Eurasian watermilfoil and dreissenid mussels.

The control and harvest of Eurasian milfoil is one of the most extensive on-going in-water activities in the Okanagan Basin. Specific guidelines based on the best available scientific information (as it develops) for protection of RMRM habitat are being developed inside the RPA to ensure consistent management practices. With continuation of the status quo, low compliance of existing protection measures and no efforts to determine and address the limiting factors of recruitment of existing populations, the extirpation of RMRM from the Okanagan Basin is likely within 10 years.

Figure 2.12: Rocky Mountain ridged mussel (*Gonidea angulata*).

Aquatic Weed Control in Washington, an Overview Focusing on Eurasian Watermilfoil

Jennifer Parsons, Aquatic Plant Specialist, Washington Department of Ecology

Washington State has a noxious weed list that includes Class A mandatory eradication (e.g. Hydrilla); Class B designated for control in regions where they are not well established (e.g. Eurasian milfoil); and Class C widespread weeds, control up to local discretion (e.g. fragrant water lily).

Aquatic weed control in Washington State includes:

- Mechanical control methods of hand pulling (tube connected to barge sucks up

pulled weeds), hand cutting or raking, bottom barrier, diver dredging, harvesting, and rototilling (only permitted in one area due to potential impacts on habitats).
- Biological control methods including grass carp (only condone use in lakes that have invasive plants they like to eat because carp can eat all vegetation and are difficult to control) and insects (weevil, midge, caddisfly).
- Water drawdown to expose to freezing or drying.
- Herbicides, including 2,4-D and Triclopyr with permits.

Hybrid milfoil may be complicating control in some lakes. The department is considering whether or not to work on eliminating it.

With sponsorship by the Okanogan Noxious Weed Control Board, a grant was awarded by the Washington DoE for the development of an Aquatic Vegetation Management Plan for Osoyoos Lake (U.S. portion) last year. The Plan includes a permit for application of a granular aquatic herbicide (e.g. Triclopyr)[4] for 10 acres of treatment on the US portion of Osoyoos Lake.

Detailed information on Triclopyr was not presented at the Forum. Fact sheets[5] published by the Washington DoE recommend, due to the (remote) potential for eye irritation in swimmers, imposing 12-hour swimming restrictions in waters after treatment with Triclopyr. Washington State Department of Health has reviewed the data and agrees that skin contact with Triclopyr treated water at the dilute treatment concentration required is unlikely to result in any adverse health effect in people. With regards to aquatic organisms, the overall weight of evidence indicates that Triclopyr's acute toxicity values of ~100 mg/L or greater with invertebrate and vertebrate species yield an US Environmental Protection Agency rating of "practically non-toxic". Some longer-term studies of the effects of Triclopyr have concluded that its metabolites are likely to have a low potential to accumulate upon repeated exposure.

"The milfoil control issue is huge and there is a great opportunity for both sides of the border to come together to manage it better. Biological control would be worth looking into on the Canadian side of the border. We also need to work on reducing the discharge of treated water into lakes, rivers, streams."

Stu Wells, Town of Osoyoos and Okanagan Basin Water Board.

IJC Plan of Study 4: Effects of Zosel Dam Water Regulation on Osoyoos Water Quality

Marc Beutal, Associate Professor, Civil & Environmental Engineering, Washington State University

The State of Washington Water Research Center performed Plan of Study 4 to inform IJC of the possible effects of Zosel Dam on water *quality* in Osoyoos Lake.

The major findings of IJC Plan of Study 4 were:
- Zosel Dam exerts no control on lake inflow and only affects lake elevation and water depth minimally from year to year (i.e., differences of a few feet). Therefore, we are unable to suggest changes in Zosel Dam operation that would directly and knowingly affect water quality in Osoyoos Lake.
- The lake's trophic status has improved from eutrophic in the 1970s to mesotrophic presently.
- Nutrient and phytoplankton levels in Osoyoos Lake are related to, and partly controlled by, upstream inflow from the Okanagan River.
- Bottom water anoxia and its effects on cold water fish is a bigger immediate concern than eutrophication risks. In-lake phosphorus is released from bottom sediments under anoxic conditions. This may exacerbate algal blooms.

[4] Other herbicides may be authorized under the permit beyond Triclopyr.

[5] See: www.ecy.wa.gov/programs/wq/pesticides/final_pesticide_permits/noxious/triclopyr_faq.pdf

2.3.2 Focus of audience interest and feedback

Audience questions and comments focused on future sewage treatment proposals, estrogen accumulation and trends in phosphorous and algae bloom risks.

2.3.3 Recommended next steps and suggested actions

- Suggested Action 2.3.1 ***Develop a bi-lateral aquatic vegetation and water quality management plan for Osoyoos Lake.*** Note: this is analogous to action 1.7 identified during the 2007 OLWSF.
  Who: OBWB (coordination), IJC (coordination),Town of Osoyoos, City of Oroville, Lake Osoyoos Association, Osoyoos Lake Water Quality Society (OLWQS), Washington DoE, Province of BC
- Suggested Action 2.3.2 ***Explore the potential of a broader water quality index for Osoyoos Lake.*** Include data for phytoplankton chlorophyll, water clarity, dissolved oxygen and emerging contaminants such as endocrine disruptors.
  Who: BC MoE and partners
- Suggested Action 2.3.3 ***Acquire additional land for wetland/riparian protection and continue wetland restoration projects, including constructed wetlands***.
  Who: Public, NGO, private sector partnerships, senior and local governments
- Suggested Action 2.3.4 ***Continue to monitor estrogen concentrations*** *in Okanagan River where dilution factors are lower.*
  Who: UBC Okanagan researchers and BC MoE
- Suggested Action 2.3.5 ***Conduct more extensive groundwater studies to fill knowledge gaps*** *including: detailed shallow groundwater flow patterns and surface water-groundwater interactions, mountain recharge and deep/bedrock flow patterns, groundwater level and chemistry conditions, trends on the east side of Osoyoos Lake, and occurrence of other potential groundwater contaminants (in addition to nitrates).*
  Who: Environment Canada, UBC Okanagan, BC MoE
- Suggested Action 2.3.6 ***Maintain collaborative partnerships*** *with ONA, DFO, OLWQS, Washington DoE and others to determine status and trends in Osoyoos Lake relative to water quality objectives.*
  Who: BC MoE, OLWQS, Okanagan Nation Alliance (ONA), DFO, Washington DoE

- IJC-PS 4 Recommendation 1 ***Focus on the continued study and control of nutrient loading to the lake rather than relying on changes in Zosel Dam operations (which have negligible impact).***
  Who: Town of Osoyoos, City of Oroville, RDCO, RDOS and member municipalities, BC MoE, Washington DoE
- IJC-PS 4 Recommendation 2 ***Explore feasibility of lake oxygenation techniques*** *(if local nutrient loading and/or anoxic conditions in Osoyoos Lake grow in severity and cannot be meaningfully mitigated by pulse flows).* This technique may be more suited to the south and central basins of Osoyoos Lake.
  Who: Washington DoE, City of Oroville, and partners
- IJC-PS 4 Recommendation 3 ***Continue to refine conditions for, and monitoring of, flushing flow experiments and assess their effectiveness*** *at mitigating temperature-oxygen squeeze mortality and other water quality effects (including potentially adverse consequences).*

Define conditions when pulse flows should be attempted, and obtain support from BC MoE that these experiments may result in sub-optimal Okanagan Lake levels or require sustaining higher Okanagan lake levels in June/July. Achieve buy-in from water managers and others that this is an acceptable short-term consequence.

Who: DFO, ONA, BC MoE

Figure 2.13: New overshot gates at McIntyre Dam to enable fish passage.

The McIntyre Dam project (Canada) involved adding overshot gates to the dam structure and constructing riffles to increase pool depth to control water velocity and enable fish passage.

2.4 Fisheries and Species at Risk

2.4.1 Key points made by presenters and panellists

Habitat Rehabilitation in the Okanogan River Sub-basin since 1997

Chris Fisher, Fisheries Biologist, Colville Confederated Tribes

The Okanogan Subbasin Habitat Improvement Project (OSHIP) focuses on rehabilitation of habitats and land acquisition for protection of critical anadromous fish habitat.

Okanogan River basin currently supports sockeye, summer Chinook, and summer steelhead.

Habitat rehabilitation efforts have focused on barrier removal (increasing access to habitat), improving water temperatures (e.g., Omak Creek (in the US) to restore habitat for steelhead, Cross Channel project above Driscoll Island), increasing flows/flow management and land acquisition.

The Cross Channel project (US) involved a passive flow distribution weir (Figure 2.14) that leads to improved watering conditions for a 2 mile reach of the east channel Okanogan River as well as enhanced cold water refugia in the Similkameen River.

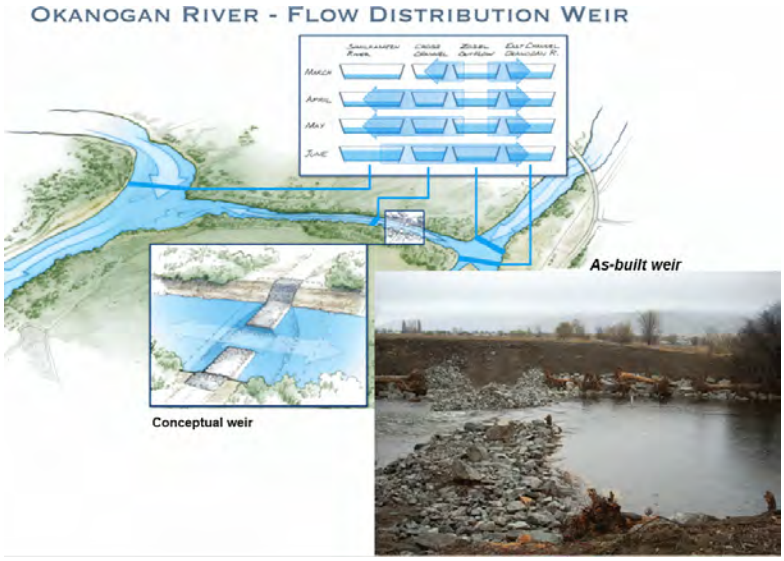


Figure 2.14: Okanagan River flow distribution weir.

The Loup Loup Creek project (US) provided unimpeded access to spawning/rearing habitat for steelhead by putting in bottomless box culverts and obtaining a long-term water lease for pumping from the Okanogan River, allowing continuous stream flow in the creek.

Salmon Return Efforts: Okanagan Nation Alliance

Karilyn Alex, Fisheries Biologist, Okanagan Nation Alliance

Dams and channelization, reduction in the length of the Okanagan River channel to half of what it once was, increased water withdrawals, reduction in wetland area by 88%, simplification of habitat, and the introduction of exotic species has led to a reduction in diversity of indigenous fish.

Status of Osoyoos Lake salmon:

- Sockeye – **rebounding**
- Chinook – rare
- Steelhead – rare
- Coho – extirpated
- Chum – extirpated
- Kokanee – declined
- Rainbow Trout – declined
- Lamprey – extirpated

The Okanagan River Restoration Initiative (ORRI) transformed a channelized section of river to complex habitat type. Property was purchased and the dyke was set back. Two oxbows were reconnected and riffles were placed in the river with boulders to create habitat and build resiliency.

Sockeye are being reintroduced to Skaha Lake by the Okanagan Nation Alliance (ONA) utilizing natural broodstock and hatchery rearing. The project is in year 6 of 12, and may in future be extended to Okanagan Lake.

The McIntyre Dam fish passage project involved replacing undershot gates with overshot gates so fish jump over the dam, and extend the amount of useable habitat. Fish can now get as far as Okanagan Falls. The goal is to extend passage into Skaha Lake through modifications to Okanagan Falls dam.

The Osoyoos Lake temperature-oxygen squeeze has become more prevalent and is impacting fish populations. The Fish/Water Management Tool (FWMT) is used to assist in management of Okanagan Lake Dam flows and temperature-oxygen squeeze mitigation.

ONA also conducts a monitoring and evaluation program to monitor the status and trends in streams and their riparian areas over time. The program is in year 6 of 20.

The ONA applied to have Okanagan Chinook salmon listed under COSEWIC. They are a very important species for the First Nations as a food source.

Future challenges include managing cumulative impacts of human populations on aquatic resources, projected population increase, climate change, and maintaining aquatic stewardship ethic.

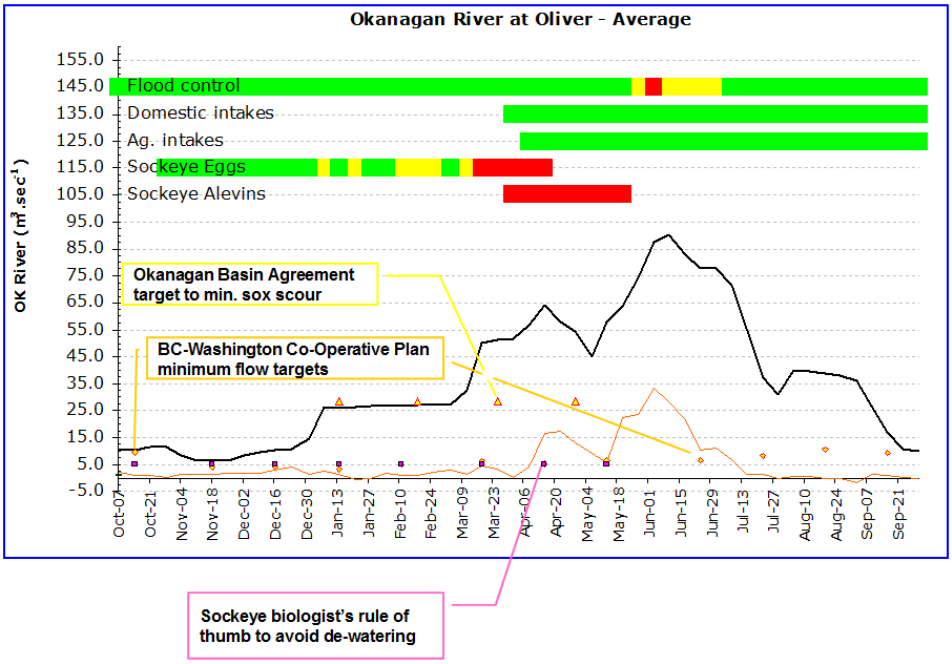
"We are dealing with complex problems in this watershed and there are many studies related to Osoyoos Lake and Okanagan River underway. The IJC will need to consider all issues and look at the research when renewing the Orders. For example, the Water Supply and Demand Project showed that there is not enough water for fish. First Nations have undefined land, water and fishing rights and IJC Orders will affect those rights."

Howie Wright, Okanagan Nation Alliance

Adapting the Fish-and-Water Management Tools Decision Support System to Balance Water Regulation Objectives for Sensitive Aquatic Biota

Dr. Kim Hyatt, Research Scientist, Fisheries and Oceans Canada

Okanagan Lake and River system (OLRS) operators must make water management decisions to address competing objectives that satisfy flood control, fisheries values, water storage/extraction, navigation, tourism, and international agreements.



Compliance with Okanagan Basin Agreement fish objectives was not good prior to 1998 as timely synthesis of information was difficult and collaboration amongst water operators and biologists was inefficient.

The Fish Water Management Tool (FWMT) computer model was developed to balance interests. A key to the tool's success has been its provision of a transparent, deep and durable representation of key issues using simple, intuitive visualizations of trade-offs (traffic light colours). A unique aspect of FWMT is its use of real-time data feeds to "auto-correct" forecasts of lake levels, flows and water temperatures.

Users of FWMT game with alternative water releases at Okanagan Lake dam in an effort to "get red out and maximize green".

Figure 2.15: Example of intuitive, dashboard output generated by the Fish Water Management Tool.

Another factor behind the success of FWMT is that the decision (water releases at Okanagan Lake dam) must be made repeatedly. This is different from other decision support systems which can lack direct linkage to real-world decisions (e.g. whether to issue a water licence, or not).

The Canadian Okanagan Basin Technical Working Group (COBTWG) FWMT Operations Team is looking to further adapt the tool to include other sensitive aquatic species. For example, the Rocky Mountain ridged mussel, which is found in the Okanagan as isolated shallow water colonies and was recently reclassified from threatened to endangered by COSEWIC. The mussel may be vulnerable to lake level variations so the FWMT could include mussel risk of desiccation to alert managers.

The new real-time dissolved oxygen and water temperature buoy on Osoyoos Lake could also be incorporated to auto-correct FWMT's predictions of temperature-oxygen squeeze in the north basin of Osoyoos Lake.

Last but not least, FWMT is also flexible and robust enough to be adapted as a risk assessment tool for Zosel Dam operations and downstream effects on chinook and steelhead in the East Channel of Okanogan River

upstream of the confluence with the Similkameen River. Many believe this extension is key to support ongoing, flexible, informed collaborations between Okanagan Lake and Zosel Dam operators and aquatic biologists that will be necessary to realize several of the IJC Plan of Study recommendations.

"We are facing a number of challenges this basin. We need a good monitoring program where we can identify changes in key ecological parameters and build good decision support systems for regulations, flows, floods, etc. Water quality is improving, but it is still a mesotrophic lake with a large milfoil problem. Our modifications have negatively affected fisheries. We need to figure out how to enhance fisheries while working within the infrastructure we have."

Richard Moy, International Joint Commission

"A tremendous increase in knowledge has occurred over last few years. Research is being done by many organizations and all kinds of knowledge and improvements are contributing to our understanding of ecosystems. Complex integrated models are helping us be better managers."

Dr. Brian Guy, Summit Environmental Consultants

IJC Plan of Study 5:
An Investigation of Methods for Including Ecosystem Requirements in Order of Approval

Dr. Cailin Orr, Assistant Professor, School of Earth and Environmental Sciences, University of Washington

The overall objectives of IJC Plan of Study 5 were to analyze existing information on fish, wildlife and plant species that demonstrate sensitivity to Osoyoos Lake water management by Zosel Dam and to address related key questions:

- What plant and animal species of special importance are affected? How and when?
- Are there ways of lessening or mitigating these impacts with changes in outflows at Zosel Dam?
- Are there gaps in present information that need to be filled to understand the effect of water regulation on Osoyoos Lake ecosystems?

The assumptions used to select and evaluate species are detailed in the Study 5 report. Based on these methods, the major findings of IJC Plan of Study 5 were:

- Three categories of species need to be considered in management decisions related to Osoyoos Lake and Zosel Dam: a) Native, planned, protected and endangered aquatic species that use Osoyoos Lake and the East Channel of Okanogan River downstream of Zosel Dam; b) Native, protected and endangered riparian and wetland species adjacent to Osoyoos Lake; and c) Invasive species in the lake and surrounding wetlands.
- Due to their ecological, cultural and economic importance in the Okanagan Basin, salmonids rank highly in the priorities for flow management. Discharge, and not lake level, is the most important criteria for maintaining healthy salmonid populations. The fisheries and in-stream flow demands below Zosel Dam are the largest component of the total water demand for Osoyoos Lake.
- Using lake level management (i.e. draw-down) for invasive species control is not practical.
- Lake levels impact riparian habitats that are important for threatened animal species such as the Tiger salamanders and Yellow-Breasted Chat. However, there is currently scant information available on the extent and manner in which wetland attribute changes affect these species.
- There will be trade-offs between management strategies to conserve native species with different habitat needs as well as to deter invasive species in the lake and downstream of Zosel Dam. Management goals will have to be developed from a prioritized list of species that the lake should be managed for (either to promote or control) and habitats prioritized for protection before *specific* management plans can be developed.

2.4.2 Focus of audience interest and feedback

Audience questions and comments focused on fish passage at McIntyre Dam, the impacts of rototilling to control Eurasian watermilfoil on indigenous plants and sensitive shoreline habitats and species, and the distribution of Rocky Mountain ridged mussel in the Okanagan Basin.

2.4.3 Recommended next steps and suggested actions

- Suggested Action 2.4.1 ***Support programs that detect and control <u>new</u> invasive species such as walleye, zebra mussels and others.***
  Who: BC MoE, Washington DoE, DFO, CCT, ONA, Environment Canada
- Suggested Action 2.4.2 ***Extend the success of the Fish Water Management Tool to operations of Zosel Dam and include other sensitive aquatic species*** *(e.g. Chinook/steelhead downstream of Zosel Dam in east channel of Okanogan River upstream of confluence with Similkameen).* Given FWMT's proven track record, this may be the most promising framework for improved communications between BC and Washington State dam operators and aquatic biologists.
  Who: COBTWG, Washington DoE, CCT, ONA
- Suggested Action 2.4.3 ***Hold bi-annual State of the Watershed conferences,*** *focused on species at risk, invasive species deterrence efforts, and to share monitoring updates on trends in valued ecosystem components.*
  Who: provincial, state, federal, First Nations, and municipal agencies and governments
- Suggested Action 2.4.4 *Continue to support and enhance resiliency as a key principal in restoration design (e.g. re-establishing habitat range for Okanagan sockeye).*
  Who: All restoration practitioners
- IJC-PS 5 Recommendation 1 ***Materially support and encourage Washington State, DFO, CCT, and ONA to agree on appropriate ecological flows and risk thresholds associated with various flow rates in the Okanogan River below Zosel Dam. Strive to meet these fisheries demands, inside of constraints.*** This consensus exercise should include a review of whether completion of the north Driscoll Island Cross Channel weir allows for a lowering of low-flow target discharges from Zosel Dam. By stopping the loss of low flow water to the Similkameen River via the effect of the Cross Channel weir, minimum targets for salmonids spawning and incubation in the east channel should be met with flows of 150-175 cfs. (The as-built veracity of these flows has yet to be verified for all target species and built into revised flow targets).
  Who: IJC, Washington DoE, CCT, ONA, DFO
- IJC-PS 5 Recommendation 2 ***Employ methods that sustain and improve suitable oxygen and temperature conditions in Osoyoos Lake*** *(i.e., pulse flows from Okanagan Lake dam, artificial oxygenation techniques).*
  Who: Province of BC, COBTWG, Washington DoE, partners
- IJC-PS 5 Recommendation 3 ***Invest in detailed habitat maps for threatened riparian and wetland species as well as related basic research on how riparian and wetland attribute changes affect target species.***
  Who: EC, Province of BC, Washington DoE, partners

2.5 Conservation and Governance

2.5.1 Key points made by presenters and panellists

The Challenge of Managing Water as a Vital Resource to Sustain Aquatic Ecosystems and Human Systems in the Okanagan Valley

Dr. Kim Hyatt, Fisheries and Oceans Canada, **Brian Symonds,** BC Ministry of Forest, Land and Natural Resource Operations, and **Dr. John Wagner,** UBC Okanagan

Physical, biological, social, economic and political realities interact to create challenges to the management of water for aquatic ecosystems and human systems. Natural ecosystems in the Okanagan have a level of biodiversity unrivalled in most areas of Canada.

Human settlement began in the mid-1800s. Human systems now dominate both terrestrial and aquatic systems and threaten water quality, quantity and ecosystem integrity.

The first dam on Okanagan Lake was constructed in 1914 for navigation and was relatively small. The Okanagan Lake dam was constructed in 1928 (image below). The South Okanagan Lands Project involved the construction of an irrigation canal that opened up the south end of valley to farming and development. The 1974 Okanagan Basin Agreement attempted to strike a balance between economic, social and environmental values.

Figure 2.16: Construction of Okanagan Lake Dam - 1928.

Figure 2.17 The meandering Okanagan River in 1938 compared to the channelized river in 1996.

The Okanagan Basin Agreement had as its legacy the construction of the Okanagan Lake Regulation System (OLRS). The OLRS includes channelization of most of Okanagan River down to the US/Canada border (for flood control and irrigation) and is defined by 4 dams, 17 drop structures and 38 km of diked channel. The result of this channelization, along with groundwater use, has been to transform the southern Okanagan from a desert into green, arable landscapes.

In 1927 the Zosel Lumber Company constructed a small rock-filled wood crib dam across the Okanogan River approximately 2.7km downstream from the outlet of Osoyoos Lake to provide a log sorting pond for a sawmill. This caused increased water levels in the river upstream of the dam. The International Osoyoos Lake Board of Control was established by Order of the IJC on September 12, 1946 to ensure that Zosel Dam was operated correctly, according to the Order. The Order addressed only the matter of water levels in Osoyoos Lake as affected by the dam. The current Zosel Dam was reconstructed in 1986-87.

The outlet of Osoyoos Lake is influenced by the Similkameen River, which has a very dominant flow in spring and can generate backwater effects when its flows exceed 10,000 cfs.

The water cycle in the Okanagan Basin is driven by snowmelt. Water must be captured to use for later part of summer. Basin inflows are highly variable, and forecasting these flows is critical for managing the system.

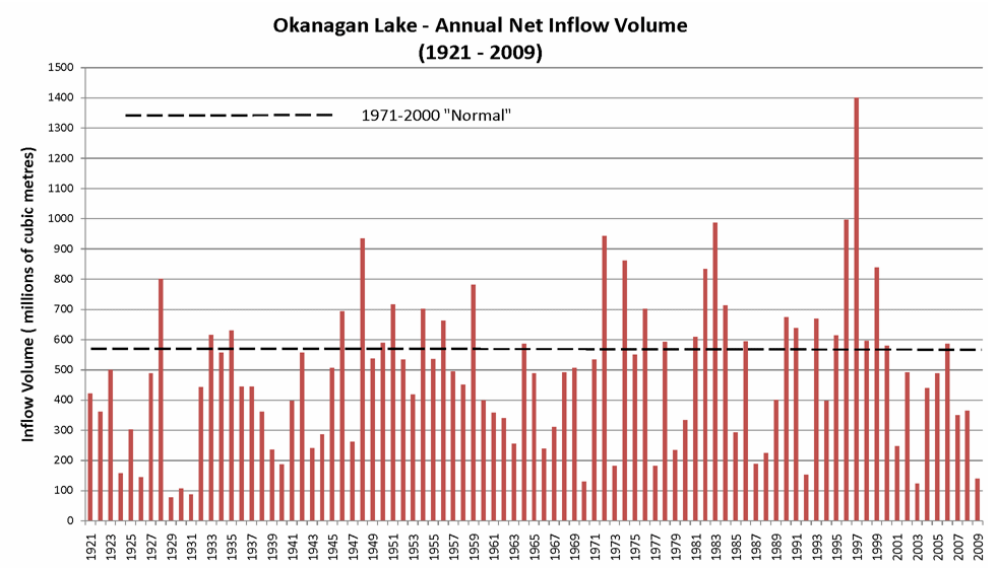


Figure 2.18 Okanagan Lake – Annual Net Inflow Volume (1921-2009).

Dr. John Wagner (UBC Okanagan) reminded the audience that water has a social life: people go where water is. It is essential to aesthetics, culture, ceremony, economy – all aspects of our lives are affected by water.

Governance is a much broader and more inclusive concept than government. It is not a job we can assign to one institution. Governance is a process that should include informal as well as formal mechanisms. Governance systems cannot be legislated in their entirety but legislation does enable key institutions system. Durable solutions occur when many organizations adopt a polycentric, inclusive process to manage water, and all key stakeholders and levels of government have a voice and role to play (distributed governance).

The current IJC Operating Orders for Zosel Dam are quite broad, but not as broad as many would like to see. In particular, they lack ecosystem protections and recognition of First Nations concerns. Dr. Wagner also noted that the terms and representation of interested groups within the international Columbia River Treaty is also too limited.

The Osoyoos Science Forum and the opportunity for input on IJC Operating Orders have provided an opportunity to learn how to participate more effectively in governance systems.

"We need to establish institutional stability in the Okanagan watershed. The best decisions are made when communities, water users, science users and government work together to solve problems. This is what an International Watersheds Initiative process strives for."

Richard Moy, International Joint Commission

"Communication and collaboration collectively is the key to moving things forward. The Board of Control has a very important job – we will take the information and studies in front of us and provide recommendations to the IJC regarding the order renewal. We have some opportunities to explore where we can soften the footprint of the managed Okanagan system."

Brian Symonds, Ministry of Forest, Land and Natural Resources Operations and Osoyoos Lake Board of Control

A Stakeholder Approach to Lake Planning

Phil Armstrong, Planning Technician, Town of Osoyoos

In 2010, a bylaw to extend the Town of Osoyoos' zoning powers over the water was given first reading but was abandoned following written public submissions and well attended public hearing and information meetings. Town staff were directed to draft a new bylaw using a stakeholder involvement process.

The Lake Recreational and Commercial Use (LRCU) task force was created. It includes members representing lake users, community members, and Town of Osoyoos representatives.

The LRCU proposed the following solutions to issues related to shoreline management:

- Greater control of approval process: rezoning required for group and strata moorage or marina.
- Limit number of boats per upland property: 3 boats per single family dwelling, 1 strip per multi-family.
- Protect public swimming areas: install 52 swim buoys and 5,000 feet of swim rope, apply for additional boating restrictions, liaise with RCMP, and apply for Licence of Occupation for waters fronting Town owned lands.
- Prohibit private moorage in front of Town lands without permission and payment: allow semi waterfront parcels and anchorage areas.
- Environmentally friendly and safe anchorage: town anchorage areas need to be cleaned up as condition of permit, promote a lake clean up day, educate, and provide proper anchors.

"The audience attending this workshop is very impressive and speaks to the diverse nature of the problems and the desire of the community to make informed decisions. Scientists get caught up in our work but the reality is that citizens need to help make decisions."

Dr. Michael Barber, Washington State University

The International Joint Commission's Bi-national Hydrographic Data Harmonization Effort International Columbia Basin Perspective

Michael Laitta, Geographic Information Systems Coordinator, International Joint Commission

The International Joint Commission is involved in an effort to sew together hydrographic datasets from the U.S. and Canada. This is the first time in 85 years that the two countries have come together to discuss data harmonization.

There are currently technical, interpretive and programmatic differences between the two countries. The IJC initiated the International Watersheds Initiative with the goal of anticipating, preventing, and resolving water resources issues and other environmental problems before they develop into international issues. The Transboundary Hydrographic Data Harmonization Task Force was formed to work on erasing the boundary from datasets. They are currently working on harmonizing drainage areas and hydro networks.

The work is being conducted in three phases: phase 1 is to develop the baseline drainage area limit and harmonize drainage area units, phase 2 is to assess the stream networks, and phase 3 coordinates a regional/local data set.

Progress has been made and we now have seamless subbasin units uninterrupted by border and connected streams. The finer scale watersheds will be filled in soon.

Harmonized data is available on USGS website (and see: www.geobase.ca/geobase/en/action/nhn-transboundary.html).

"It is nice to see so many different organizations working together. There are many opportunities to build partnerships across the border. The IJC and Board of Control are here to help facilitate discussions. Citizens have the power to influence decision making and to implement environmental change."

Dr. Cindi Barton, Osoyoos Board of Control

Water Conservation: Attitudes and Actions in the Okanagan

Dr. John Janmaat, Associate Professor of Economics, UBC Okanagan

People conserve water based on moral and economic considerations. If money dominates then it should be a matter of raising the price to see a conservation response. If morals dominate, then education and persuasion would be the more appropriate means of achieving behavioural change (conservation).

A survey of Kelowna households was conducted in 2009 focusing on the boundary areas between the five water purveyors in Kelowna. 516 responses were received.

The respondents were asked questions about what actions and investments they are taking to reduce water use and what influences these actions and investments have on their consumption.

Low flow showers and toilets were reported as the most common indoor investment and timed irrigation the most common outdoor investment.

The most common conservation behaviours were found to be running the washing machine and dishwasher only when full and turning off the tap when brushing teeth and soaping up.

The survey results did not show a clear relationship between indoor/outdoor investments and behaviour changes.

Kelowna water purveyors charge differently, some by volume and some a flat rate. If economics dominate consumption behaviour, customers that pay for what they use should do more to conserve water. If moral considerations dominate there should be no difference.

No difference in environmental attitudes and perspectives and knowledge about Okanagan water issues was found between the utilities (except in the South East Kelowna Irrigation District where consumers were more concerned with availability).

The survey suggested that who the purveyor is and what prices they charged did not seem to be driving behaviour.

Most notably, the results of spatial regression on survey results showed that people are influenced most by what their neighbours do and the more ways a person receives information about conservation ('messages') the more likely they are to conserve. "Doing the right thing" and existing pricing systems[6] did not have a noticeable effect on water use.

The 'New' Columbia River Treaty: Should the Okanagan Be Included?

Dr. John Wagner, Environmental Anthropologist, UBC Okanagan

The Columbia River is the most dammed river in North America. The term of the existing Columbia River Treaty aimed at helping guide this hydrosystem is 60 years: 1964-2024. The Treaty will continue in force unless either Canada or the United States give 10 years notice to terminate (2014).

Many studies have been conducted on both sides of the border and public consultation processes are underway.

The Treaty brought affordable electricity, flood control, economic development, and peaceful international relations. But problems caused by the Treaty include: destruction of fish populations, environmental degradation, flooding of aboriginal lands and cultural sites, flooding of agricultural lands, and impediment of movement to an enlightened governance system.

Benefits of the Treaty have not been uniformly shared. For example, there is far more commercial agriculture in the US than in the Canadian portion of the Columbia Basin. About 8 million acres are now being irrigated in the US from the Columbia River and its tributaries. In fact, British Columbia suffered a significant reduction in agricultural land holdings and agricultural production as a result of the Columbia Treaty.

[6] The study did not address what level of price increases would reduce people's water consumption habits.

Deficiencies in the Columbia River Basin governance system include: lack of consensus on how to value competing interests and achieve a balance among them, lack of over-arching governance model that all actors can support, and lack of an international agreement on the full range of governance issues at stake.

Dr. Wagner's recommendation is to develop a far more comprehensive and inclusive Columbia Basin Treaty that includes the Okanagan and create an International Commission to oversee and coordinate achievement of revised Treaty goals.

Shankers Bend Dam update:
The Okanogan Public Utility District has withdrawn its application to the Federal Energy Regulatory Commission to build a new Shanker's Bend Dam.

"We need to make sure there is a means to continue discussion on cross-boundary issues, whether it is used to inform the IJC, governors of state, or leaders of province and country. A process was started in 1999 but it is dying due to lack of funding."

Chris Branch, City of Oroville.

The International Joint Commission and the Osoyoos Review of Orders

Tom McAuley and Mark Colosimo,
International Joint Commission

The International Joint Commission (IJC) is considering new information and science in the renewal of the Operating Orders (the "Orders") for Zosel Dam / Osoyoos Lake. Renewal must occur before February 2013, when the current Orders expire. Currently, a local management board of the IJC, the International Osoyoos Lake Board of Control, administers the Operating Orders. The Board of Control has recently completed a series of eight (8) technical studies intended to inform the Board of Control and guide its deliberations during renewal of the Orders. This set of technical studies is referred to as the Plan of Study.

In any matter or procedure within the IJC's jurisdiction under the 1909 Canada-US Boundary Waters Treaty, all interested parties shall be given a convenient opportunity to be heard. This applies to the review and renewal of the Zosel Dam / Osoyoos Order which sunsets in February 2013. Along with public meetings in the area later in 2012, the Commission will also be receiving written concerns from the public throughout the period before it completes its deliberations.

The IJC is exploring ways in which it can better contribute to the overall sustainable health of transboundary river basins. A forward-looking exercise by the Commission resulted in the document "The IJC and the 21st Century", and initiated the Commission's International Watershed Initiative (IWI) (IJC 2009).

Table 2.3: Schedule leading up to the renewal of the Osoyoos Lake Orders.

Date	Activity
2011 Fall	Osoyoos Lake Water Science Forum - Public familiarization and early comments on the 8 Osoyoos Plan of Study reports
	Osoyoos Board initial input on conclusion of 8 Plan Studies
	Board summary report and recommendations to IJC; (+ dialectic)
2012 April	IJC briefs Gov'ts of Canada and US on progress of Osoyoos review
2012 Summer+	IJC holds public hearings; Receives all forms of public comment
2012 Oct	Semi-Annual Meeting with Governments – Brief Governments on the progress
2012 Nov–Dec	Completion of renewal of Orders

Along with its Osoyoos or possible alternative IWI Boards, the IJC seeks ways to encourage a more integrated, ecosystem based approach in working within the Okanagan basin (IJC 2009). The Commission's International Watershed Initiative also expressly recognized the need to include formal adaptive mechanisms to adjust and respond to new knowledge and surprises (IJC 2009).

Possible directions include continuing with the Board of Control (perhaps with modified membership and responsibilities) or moving towards an IWI that would involve forming a board with additional local representatives. Hence, the IWI facilitate the development of watershed-specific responses to emerging challenges. The underlying premise is that local people are well positioned to resolve many local transboundary problems.

Mr. McAuley's presentation identified the strengths of the IJC, which include: an independent unitary body, efforts to prevent and resolve transboundary disputes, seeks common good by deliberation and consensus, pursuit of mutual trust and professionalism, and use of a scientific basis for its recommendations.

"We fully support exploring the Integrated Watersheds Initiative. The OBWB works to unite jurisdictions in order to look at issues and apply treatments for the valley as a whole. We've had to cut off the bottom of the watershed that falls in the US so there is a disjoint in mapping, milfoil control and other water management issues. The IWI approach sounds like it would help convene people on both sides of the border and provide a focus point for resources."

Dr. Anna Warwick Sears, Okanagan Basin Water Board

"The Integrated Watersheds Initiative could be exciting and prove beneficial to the Okanagan Basin. There will be questions that arise, such as whether or not the Similkameen should be part of it. I am proud to see the community come out to this conference and hope that now people have a better idea of what the IJC is and how they make decisions and how the community can be more involved in the IJC process."

Panellist **Stu Wells,** Town of Osoyoos and Okanagan Basin Water Board

2.5.2 Focus of audience interest and feedback

Audience questions and comments focused on the potential creation of an International Watershed Initiative, involvement of First Nations people in decision-making, details of the Columbia Basin Treaty, renewal of the IJC Operating Orders for Zosel Dam, and water pricing and conservation.

2.5.3 Recommended next steps and suggested actions

- Suggested Action 2.5.1 ***Foster partnerships with Aboriginal peoples in Canada and the United States that create space for meaningful dialogue, including decision-making votes on matters that fall within the revised scope of the Orders in the Okanagan region.***
  Who: IJC, Government of Canada, US Federal government, Columbia Basin First Nations in Canada and US
- Suggested Action 2.5.2 ***Explore the implementation of an International Watersheds Initiative (IWI) process for the Okanagan/Okanogan Basin.*** Along with the potential increased scope of responsibilities, an important issue is to have more representative membership, including First Nations and other local knowledge holders.
  Who: IJC, Government of Canada, US Federal government and regional partners (e.g., OBWB)

2.6 Land Use Planning

2.6.1 Key points made by presenters and panellists

Osoyoos Lake Foreshore Inventory Mapping Project

Jason Schleppe, Principal, Ecoscape Environmental Consultants Ltd

The purpose of the Foreshore Inventory Mapping (FIM) and Aquatic Habitat Index process is to quantify and document the current state of the foreshore in an area and use that information to help develop policy and guide planning and land use decisions.

It is a 3 step process: step 1 is to conduct Foreshore Inventory Mapping (FIM) to provide background information about the shoreline, step 2 is to develop the Aquatic Habitat Index (AHI) to provide environmental sensitivity analysis of the shoreline using existing biological data and the FIM database, and step 3 is to prepare shoreline management guidelines that take a comprehensive look at the types of development and associated levels of risk.

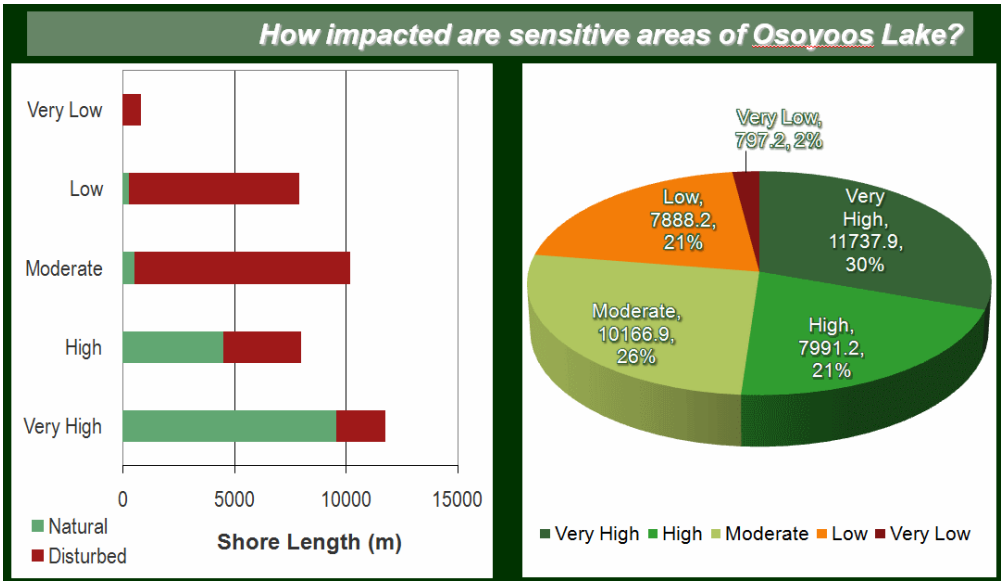


Figure 2.19: Foreshore Inventory Mapping assessment of level of impact to Osoyoos Lake sensitive areas.

The Osoyoos Lake shoreline consists of mostly disturbed gravel beach with a low slope. Osoyoos Lake shoreline modifications include substrate modification along 61% of the shoreline, 289 retaining walls, 250 docks, 47

concrete boat launches, 9 marinas with over 6 boat slips, and 16 groynes.

The main land uses along the Osoyoos Lake shoreline are rural and single family. The higher density areas are 90-95% disturbed. Rural areas contain more natural shoreline but the magnitude of disturbance is the same as in high density areas. Overall, nearly 52% of the Osoyoos Lake shoreline has a high level of impact.

There are still areas of very high value that are largely intact. 38% of the shoreline is natural. Most, if not all, important resources are present and can be managed to maintain existing habitat values (if recent trends in land use are better managed).

Important considerations that are critical to successful foreshore management include having an integrated approach for shoreline and streambank monitoring, conducting education, outreach and engagement to change behaviour, ensuring compliance and enforcement of violations, and setting clear targets and objectives that can be tracked through trend/change monitoring.

The next step with this work is to prepare Shoreline Management Guidelines for Osoyoos Lake.

Okanogan Watershed Plan – Purposefully Taking the Long Road in Water Management

Craig Nelson, District Manager, Okanogan Conservation District

Challenges faced during development of the Okanogan Watershed Plan included natural resource constraints related to the geography and geology of basin, socio-economic considerations (population in Canada high, lower in US), and a reluctance to participate due to history of other plans.

A lack of data to inform a water budget was a major limitation. All weather stations are on the valley floor and there is very little data at higher elevations where water actually comes from.

The Okanogan Watershed Plan has 46 goals and 116 strategies to implement the goals. A key goal is to develop a local water bank where people can trade water rights. The watershed is currently facing a huge issue of people selling water rights to other users downstream.

The plan was finished in June 2009 and was well-received at public hearing.

City of Oroville, Development, Planning Trends, Water Impacts: What's Allowed in Terms of Foreshore Alteration

Chris Branch, Community Development Director, City of Oroville

Recent economic and development trends in Oroville are defined by impacts of the 2008+ recession: retail sales declining, a few small businesses have closed doors, no demand for vacation homes, condo and summer home development slowing. On the positive side, one new agricultural based business (carbon cycle crush) has opened, and the Oroville Kiln Company has expanded.

There have been changes in Oroville's incorporated boundary since 2007, and it now includes more of the lake. Most new cottages are built at the Veranda Beach development. Cluster development was used along the shoreline and a lot of area is protected space. The development created motivation for a sanitary sewer.

Figure 2.20: Veranda beach development, Oroville.

The 30-unit Sandalia development was permitted under Okanogan County Shoreline Master Program with a setback of 25 feet from shoreline. It includes a dock and boatlift

permitted by City and closely monitored. Also included wetland mitigation and public trail designation.

Sonora Shores is a phased redevelopment of an old mobile home/RV park. It has a 50 foot setback.

River Oaks on the Similkameen River shore, 50' setback and includes a trail for shoreline access and a stormwater swale.

Oroville currently implements two Shoreline Master Programs – the pre-annexation-Oroville 1995 program and the post-annexation-Okanogan County 1976 program.

The Shoreline Management Plan has been updated with the goal of no not net loss of ecological function and value. It includes revised shoreline setbacks of 50 – 100 feet total depending on the use designation.

Shortfalls of the program include incentives for sustainable development, clear management objectives for the channel above Zosel Dam, and a need for a better understanding of sustainable economies.

"We need to start thinking more as a community and have conversations with people from both sides of border. We should expand our view beyond the lakeshore and look uphill to identify issues impacting water bodies. Focus efforts on areas we are trying to protect but also consider that issues can come from further away than imagined."

Craig Nelson, Okanogan Conservation District

2.6.2 Focus of audience interest and feedback

Audience questions and comments focused on public access to lakes and rivers, foreshore inventory mapping methods, riparian setbacks, and illegal dock construction. A number of audience members called for the Town of Osoyoos to develop enforceable guidelines for recreational boat use near sensitive shoreline areas, noise, speed and density of boats allowed on the lake at any one time, including later evening hours.

2.6.3 Recommended next steps and suggested actions

- Suggested Action 2.6.1 ***Limit sprawl and regulate where development is happening and what kind of landscape people are using.***
  Who: Local governments
- Suggested Action 2.6.2 ***Develop and enforce responsible on-lake recreation guidelines for different categories of on-lake recreational activity*** (water by-laws, maximum boating density, education, safe areas, etc.). Osoyoos Lake is not just an amusement park for power boat and jet-ski enthusiasts.
  Who: Town of Osoyoos, City of Oroville and Provincial/State governments. 97 Okanagan Alliance
- Suggested Action 2.6.3 ***Prepare Shoreline Management Guidelines for Osoyoos Lake based on the Foreshore Inventory Mapping and Aquatic Habitat Index.*** Continue integrated foreshore monitoring, education and outreach. Define targets/limits for development. Will eventually require new foreshore development by-laws.
  Who: Town of Osoyoos and partners

3.0 PROGRESS MADE SINCE 2007 FORUM

The inaugural OLWSF was held September 16-18, 2007 and was attended by over 190 enthusiastic and concerned presenters, panellists and participants representing the scientific community, government, business and residents from Canada and the United States. The Forum reflected the growing public concern for the sustainability of Osoyoos Lake, its water quantity and quality, and the growing sense among area residents that their quality of life is threatened (see: Alexander and Robson 2007).

Twenty-six (26) specific actions and steps for further scientific investigation emerged from the 2007 Forum. Figure 3.1 shows how these twenty-six actions are grouped according to the six of the major themes addressed during the 2007 Forum: 1) water quantity, 2) water quality, 3) land-use and agriculture, 4) ecological rehabilitation and endangered species protection, 5) governance and 6) climate change mitigation and adaptation. Most Okanagan water professionals and stakeholders do not weigh all actions equally. For example, some of the recommended actions were applicable to a small relative scale (e.g. 1.9 - mapping groundwater aquifers on East side of Osoyoos Lake), while others were strategic and far reaching (e.g. 1.5 – concrete timeline for implementing universal water metering throughout Okanagan, or, 4.4 – strengthen endangered species legislation in BC and Canada).

Figure 3.2 outlines progress made on these twenty-six actions over the last four years, highlighting successes and areas where more work is required. The actions are rated according to four categories:

- Good to Excellent
- Fair to Good
- Fair or no Progress
- Unknown

These *qualitative* ratings are based on interviews with the leaders identified in the 2007 Forum report and others actively working on the various water topics in question. A Fair to Good rating indicates meaningful, measureable investments and progress has been made, but there is more to do before the item is truly "complete". A high proportion of the items rated as Good to Excellent may be considered complete or have concrete plans and programs in place that if maintained, will accomplish their intent.

Twenty of the twenty-six actions identified during the 2007 Forum were rated as having Fair/Good to Excellent progress (77%). Though there has been considerable progress, the bulk of remaining work identified during the 2007 Forum lies in areas related to water quantity management and ecological and endangered species rehabilitation/ protection (Figure 3.3).

Section 5.0 of the report refreshes the list of priority actions emerging from the recommendations and advice of 2011 Forum presenters, panellists and participants. Some of the actions that have seen only fair or no progress are re-identified by the participants of the 2011 Forum (e.g. 1.7 Develop a bi-lateral Osoyoos Lake Management Plan). Future reviews of water stewardship progress in the south Okanagan should return to the 2007 Osoyoos Lake Water Science Forum actions in addition to the priority actions that emerged from the 2011 Forum.

1/ Water Quantity	2/ Water Quality	3/ Land-use & Agriculture	4/ Ecological Rehabilitation & Endangered Species Protection	5/ Governance	6/ Clim Mitigatior
1.1. Form storage-flow monitoring task force to track& monitor all water storage projects throughout Okanagan/ Similkameen/Shuswap.	2.1. Plan & implement additional water treatment between Oliver & Osoyoos	3.1. Concrete programs to improve on-farm water management & reduce nutrient loadings.	4.1. Establish a comprehensively integrated ecological monitoring program (First Nations, Provincial/Federal governments, UBC-O, municipal govt.)	5.1. Hold a follow-up Osoyoos Lake Water Science Forum.	6.1. Continue track outcom climate chan scenario rese
1.2. Provide coordinated input on the 2013 Osoyoos Lake Board of Control replacement Orders, incld. input from local residents.	2.2. Take more detailed sediment core sample in north and south basins of Osoyoos Lake. Reconstruct chemical history since 1900s.	3.2. Increase profile of & access to agricultural water demand modelling results that show optimal water requirements by crop x soil.	4.2. Foster partnerships to raise funding for land procurement to support ongoing & new riparian restoration.		
1.3. Ensure Okanagan Basin Water Supply/Demand Study results widely disseminated by those authorizing development & water licences.	2.3. Establish water quality monitoring in wells below settling lagoons around Osoyoos Lake.		4.3. Define specific natural habitat refuges around Osoyoos Lake foreshore to serve as seed banks and make these off-limits to development/vehicles.		
1.4. Full review of surface water licences & concrete policy changes (e.g., buy-back/transfer mechanisms).	2.4. Township of Osoyoos stormwater management plan.		4.4. Strengthen endangered species legislation in British Columbia and Canada.		
1.5. Concrete timeline for completing universal water metering throughout Okanagan			4.5. Adaptive management experiments on mitigating temperature-oxygen squeeze mortality for juvenile sockeye in Osoyoos lake.		
1.6. Identify funding to complete a professional Okanagan water historiography with Web Hallauer.			4.6. Continue to investigate sockeye salmon rebuilding potential in Skaha Lake.		
1.7. Develop a bi-lateral Osoyoos Lake Management Plan.					
1.8. Public education campaign around water saving technologies and xeriscaping.					
1.9. Map groundwater aquifers on the East side of Osoyoos Lake.					
1.10. Research on total groundwater discharge into Osoyoos Lake.					
1.11. Improve inflow forecasting for Okanagan and Similkameen basins.					
1.12. Support & track outcomes of research on hydrologic impacts of Mountain Pine Beetle.					

Figure 3.1: Twenty-six actions emerging from the 2007 Osoyoos Lake Water Science Forum arranged according to theme.

Excellent - Good	Good - Fair	Fair or No Progress	Unknown
1.2. Coordinated input on the 2013 Osoyoos Lake Board of Control replacement Orders	1.3. Okanagan Basin Water Supply/Demand Study results widely disseminated by those authorizing water licences	1.1. Track & monitor all storage-flow projects throughout Okanagan/Similkameen/ Shuswap	1.11. Improve inflow forecasting for Okanagan and Similkameen basins
2.1. Plan & implement additional water treatment between Oliver & Osoyoos	1.4. Full review of surface water licences & concrete policy changes	1.7. Develop a bi-lateral Osoyoos Lake Management Plan.	1.9. Map groundwater aquifers on the East side of Osoyoos Lake
2.2. Detailed sediment core sample in Osoyoos Lake. Reconstruct chemical history	1.5. Concrete timeline for completing universal water metering throughout Okanagan	4.4. Strengthen endangered species legislation in British Columbia and Canada	
2.4. Township of Osoyoos stormwater management plan	1.10. Research on total groundwater discharge into Osoyoos Lake	1.6. Identify funding to complete a professional Okanagan water historiography with Web Hallauer	
3.1. Concrete programs to improve on-farm water management & reduce nutrient loadings	1.8. Public education campaign around water saving technologies and xeriscaping		
3.2. Increase profile of & access to agricultural water demand modelling results	1.12. Research on hydrologic impacts of Mountain Pine Beetle		
4.5. Mitigating temperature-oxygen squeeze mortality for juvenile sockeye in Osoyoos lake	2.3. Water quality below settling lagoons around Osoyoos Lake		
4.6. Sockeye salmon rebuilding in Skaha Lake	4.1. Establish a comprehensively integrated ecological monitoring program		
5.1. Hold a follow-up Osoyoos Lake Water Science Forum	4.2. Partnerships to raise funding for land procurement in support of riparian restoration		
6.1. Continue to support regional climate change and water budget research	4.3. Natural habitat refuges around Osoyoos Lake foreshore		

Figure 3.2: Progress ratings on the twenty-six actions emerging from the 2007 Osoyoos Lake Water Science Forum.

1/ Water Quantity	2/ Water Quality	3/ Land-use & Agriculture	4/ Ecological Rehabilitation & Endangered Species Protection	5/ Governance	6/ Climate Change Mitigation & Adaptation
1.1. Track & monitor all storage-flow projects throughout Okanagan/Similkameen/ Shuswap	2.1. Plan & implement additional water treatment between Oliver & Osoyoos	3.1. Concrete programs to improve on-farm water management & reduce nutrient loadings	4.1. Establish a comprehensively integrated ecological monitoring program	5.1. Hold a follow-up Osoyoos Lake Water Science Forum	6.1. Continue to support regional climate change and water budget research
1.2. Coordinated input on the 2013 Osoyoos Lake Board of Control replacement Orders	2.2. Detailed sediment core sample in Osoyoos Lake. Reconstruct chemical history	3.2. Increase profile of & access to agricultural water demand modelling results	4.2. Partnerships to raise funding for land procurement in support of riparian restoration		
1.3. Okanagan Basin Water Supply/Demand Study results widely disseminated by those authorizing water licences	2.3. Water quality below settling lagoons around Osoyoos Lake		4.3. Natural habitat refuges around Osoyoos Lake foreshore		
1.4. Full review of surface water licences & concrete policy changes	2.4. Township of Osoyoos stormwater management plan.		4.4. Strengthen endangered species legislation in British Columbia and Canada.		
1.5. Concrete timeline for completing universal water metering throughout Okanagan			4.5. Mitigating temperature-oxygen squeeze mortality for juvenile sockeye in Osoyoos lake		
1.6. Identify funding to complete a professional Okanagan water historiography with Web Hallauer.			4.6. Sockeye salmon rebuilding in Skaha Lake		
1.7. Develop a bi-lateral Osoyoos Lake Management Plan.					
1.8. Public education campaign around water saving technologies and xeriscaping.					
1.9. Map groundwater aquifers on the East side of Osoyoos Lake.					
1.10. Research on total groundwater discharge into Osoyoos Lake.					
1.11. Improve inflow forecasting for Okanagan and Similkameen basins.					
1.12. Research on hydrologic impacts of Mountain Pine Beetle					

Figure 3.3: Progress ratings on the twenty-six actions emerging from the 2007 Osoyoos Lake Water Science Forum, grouped according to major theme.

4.0 REFLECTIONS ON THE RENEWAL OF OPERATING ORDERS

Commission mixte internationale
Canada et Etats-Unis

International Joint Commission
Canada and United States

4.1 History of the Order of Approval for Zosel Dam

The International Osoyoos Lake Board of Control was established by Order of the International Joint Commission (IJC or "Commission") in September 1946 to ensure implementation of the Orders of Approval for Zosel Dam.

The IJC has jurisdiction over waters that cross the boundary between Canada and the United States in situations where an activity (such as building Zosel Dam) on one side of the border affects the other. The Orders of Approval for Osoyoos Lake have historically been limited to the issue of Osoyoos Lake levels, and the timing of lake level changes. This scoping of the Orders has come about because of the potential for conflict in priorities when attempting to meet downstream flow needs (in the United States) and achieving Osoyoos Lake levels and other upstream water management targets (e.g. lake levels on Okanagan Lake and flows in Okanagan River upstream of Osoyoos Lake).

The IJC derives its standing, principles and mechanisms from the Boundary Waters Treaty of 1909. The Treaty requires that the IJC give all interested parties the opportunity to be heard on matters under consideration. The Treaty includes 14 'Articles' that define obligations, responsibilities and powers.

Zosel Dam was built in 1927 on the Okanogan River 2.7 km (1.7 mi) below Osoyoos Lake by the Zosel Lumber Company to create a log storage pond. In 1980, the State of Washington sought the Commission's approval to construct works replacing the deteriorating control structure. Construction of the new Zosel Dam was completed in 1987. Orders of Approval were issued by the IJC in 1982 and a new International Osoyoos Lake Board of Control was established to supervise the operation of the new structure in compliance with IJC Operating Orders. The 1982 Order of Approval is included in Appendix B.

One of the Board of Control's current responsibilities is to issue drought declarations that guide the operation of Zosel Dam, and their removal when criteria contained in IJC Operating Orders are satisfied. Such declarations allow Washington to raise Osoyoos Lake to a higher level than is normal during non-drought conditions.

During non-drought years, the lake elevation is held between a maximum elevation of 911.5 feet and a minimum elevation of 909.0 feet. However, during a drought year, water may be stored to lake elevation as high as 913.0 feet. Zosel Dam effectively controls the elevation of Osoyoos Lake except during periods of very high snowmelt runoff when conditions force the lake above elevation 913.0 feet.

Actual operation of Zosel Dam is conducted by the Oroville and Tonasket Irrigation District under contract to the project owner, the State of Washington Department of Ecology (WDoE).

The current Order of Approval is set to expire on February 22, 2013. The IJC must decide before then whether to renew the Order as-is or modify it. The Board of Control will provide recommendations to the IJC based on the results of the eight scientific studies discussed in this report, public consultation,

and other relevant sources of information (including this report).

4.2 Non-binding Cooperation Plan between British Columbia and Washington State

The operator(s) of Zosel Dam adjust the outflow to regulate Osoyoos Lake levels in accordance with IJC Operating Orders (and their understanding of future inflow conditions). In addition, the Zosel operator(s) attempt to manage lake outflows to achieve downstream targets following a non-binding "Cooperation Plan" developed in 1980 between the Province of British Columbia and Washington State. The Cooperation Plan is not part of the IJC Operating Orders, and was developed because downstream flows were excluded from the Orders in 1982. Specifically, downstream flow targets have been specified by (1) the Zosel Dam Operating Procedures Plan Fisheries Criteria (Washington State Department of Ecology 1990, p.64), and (2) the Washington Administrative Code (WAC 1988) that established instream flow requirements for the Okanogan River in agreement with the Washington State Water Resources Act of 1971. Operations at Zosel Dam attempt to meet the downstream flow targets outlined in these documents, while meeting lake level targets set by the IJC Operating Orders taking precedence. The Cooperation Plan states: "*both governments recognize that the sharing of international waters also imposes the responsibility of mutual trust, harmony, and understanding. It is in this spirit of friendship and cooperation that this plan has been developed.*"

The 1982 Order recognized that a Cooperation Plan had been prepared and agreed to by the State of Washington and British Columbia that considered the matter of transborder flows, but the IJC determined that this plan should not be incorporated into the Order as it could jeopardize Osoyoos Lake levels and infringe on Canadian discretion for upstream water management needs.

Given the importance of inflow hydrology to Osoyoos Lake levels, cooperative options exist for the IJC to approach downstream flows through support of non-binding mechanisms.

4.3 Process for Renewal of the Order of Approval for Zosel Dam

The process and approximate timeline for renewal of the Order of Approval for Zosel Dam is as follows:

Fall 2011:
Public familiarization and comments on the eight Osoyoos studies**.** Board provides initial input on conclusion of studies and gives a summary report with recommendations to IJC. Board seeks new application from Washington.

April 2012:
IJC briefs to Canada and US governments on progress of Osoyoos Review.

Summer and Fall 2012:
IJC holds public hearings and receives all forms of public comment.

October 2012:
IJC holds semi-annual meeting with governments, briefs them on progress.

November - December 2012:
IJC completes the renewal of Orders.

"We have 15 months to settle these important orders. We want to listen carefully to what the folks on the ground have to say. We will be looking to you for solutions."

Lana Pollack, International Joint Commission

4.4 Towards 2013 – Considerations for the IJC and Board of Control

Reflecting on the information and recommendations made by IJC Plan of Study authors, presenters, panellists and audience members, three key themes emerged. These themes are interrelated, and provide a set of informed perspectives for the IJC and Board of Control to consider as they structure decisions heading into 2013.

THEME 1:
Create opportunities for success: acknowledge both the need for a broader scope of bilateral activities and the existence of constraints.

A clear theme from the Forum, and from the IJC Plan of Study reports, is that the current IJC Board of Control mandate leaves a number of important aspects of the health of Osoyoos Lake unresolved. There was also much discussion among participants about whether the representation of the Board of Control could be expanded to include First Nations and other local representatives. Suggested alternatives included making the Board larger, or forming and linking with external committees/advisory bodies.

The Board of Control should also increase the profile of the constraints on what is possible. The authors of IJC Studies 1, 2 and 3 all emphasized that Osoyoos Lake has limited regulated storage capacity and lake levels are constrained by the available inflow, which is almost completely dictated by the releases from Okanagan Lake (not Zosel Dam operations). The authors of IJC Studies 1, 2, 3 and 5 also identified that recommended instream fisheries flows account for nearly 90% of the total demand. The authors of Study 5 were clear in reinforcing the importance of downstream flows: "*discharge, and not lake level, is the most important criteria for maintaining healthy salmonid populations*." The magnitude of the challenge was identified by the authors of Studies 2 and 3, who demonstrated that to more regularly meet recommended fisheries criteria, Osoyoos Lake levels would need to frequently be drawn down below 909.0 feet or additional storage considerations and releases from Okanagan Lake coordinated. The authors of Study 1 recommended that, to better accommodate instream and fisheries needs, flow criteria should be addressed in the renewed Orders.

Numerous recommendations were brought forward at the Forum and in the IJC Plan of Study to further refine acceptable downstream flows and develop strategies to better achieve these targets. The authors of Study 1 and 5 recommended structuring Orders for Zosel Dam to consider flows and lake elevation targets within a system-wide water management frame. The lead (Canadian) authors of five of the eight IJC Plan Studies (Dr. Brian Guy, Don Dobson and James Mattison) took a different approach, recommending in a November 2011 memo to the Okanagan Basin Water Board that the IJC continue the historic practice of limiting the IJC Operating Orders to governing the levels of Osoyoos Lake, and not formally include downstream flows.

While opinions differed on the appropriate scope of the renewal Orders themselves, study authors agreed on the need for enhanced cooperation between British Columbia and Washington to balance flow needs downstream of Zosel Dam while respecting goals for Osoyoos Lake elevations and limits on releases that are possible from Okanagan Lake Dam.

Acknowledgment in the Orders of the importance of downstream flow needs as well as the hydrologic constraints to realize these targets will help catalyze new opportunities for cooperation and success.

THEME 2:
Enhance cooperation while respecting sovereignty.

The IJC has not included downstream flow targets as firm 'rules' within the IJC Operating Orders because increasing downstream flow would require increasing water deliveries from Okanagan Lake Dam in Canada. Indeed, the IJC cannot require Canada to manage inflows to Osoyoos Lake unless both countries asked the IJC to make a decision on Osoyoos Lake inflows by way of a reference to the Boundary Waters Treaty. It is doubtful Canada would agree to this due to the precedent it sets for other transboundary waters, and it is known that BC generally opposes such an arrangement due to the operating constraints it would place on management of Okanagan Lake.

Instead, the non-binding BC – Washington Cooperation Plan contains minimum transboundary flow guidelines that both governments attempt to meet in "the spirit of mutual trust, harmony, understanding and cooperation." The Province of British Columbia views the Cooperation Plan as voluntary, and it does not acknowledge any guarantee to transboundary flow, but rather, supports the flows and procedures of the Cooperation Plan procedures as far as practicable.

Regardless of whether Zosel Dam flow guidelines are formalized or left in non-binding cooperative agreements, Osoyoos Lake levels and downstream flows below Zosel Dam will continue to be driven by releases from Okanagan Lake dam at Penticton. Any activities – formal or not – that serve to increase communication and understanding over the joint trade-offs present in the larger Okanagan Basin will improve opportunities for meeting multiple objectives. IJC Plan of Study authors, Forum presenters and panellists were generally in favour of the IJC sponsoring this cooperation.

THEME 3:
Flexibly balance trade-offs using and supporting the best tools and science.

Trade-offs commonly occur when operating a dam for multiple objectives. Water levels in Osoyoos Lake are desired to be high in summer to store water for irrigation and for instream flow purposes downstream of Zosel Dam. High levels are preferred by boaters and other recreational users to allow safe passage across the bars and to prevent propellers from striking bottom in some areas. However, high levels cover the beaches and restrict areas for sunbathing and playing. At high levels, waves from storms and boat wakes cause erosion that affects lakeside property. At levels above 912.5 feet, flooding is seen in some areas and the high water table leaves some grassy areas soggy, restricting use and creating mosquito breeding areas. In the winter, it is desired that the lake be drawn down to protect property from winter storms and ice damage. All of these considerations must be balanced to determine an acceptable operating regime.

Authors of IJC Plan of Study reports emphasized the need for greater flexibility in IJC Operating Orders to balance trade-offs, pointing out that even within a single objective, there is often no win-win scenario. For instance, the authors of IJC Studies 2 and 3 recommended eliminating the all or nothing, drought declaration approach when managing Osoyoos Lake levels. Rather, they recommended following a single, flexible management regime applied for both normal and drought years (Figure 4.1). As shown by Plan of Study authors and during several Forum presentations and discussions, the existing Orders have sometimes led to chasing narrowly conceived lake elevation targets (especially in the month of April) rather than applying best science, information and tools.

Figure 4.1: Recommended Osoyoos Lake elevation management plan (blue).

Participants of the Forum also heard about the need for Zosel Dam operators to have better information, and be able to react more quickly to current and forecast conditions downstream and upstream, and on the often unnecessary holding of high waters behind the dam. There are times in the historical flow records when the inflow to Osoyoos Lake was increasing while the outflow was decreasing and was below the fisheries flow criteria. Better communication tools between the operators of the dams in BC and the operator of Zosel Dam is necessary. Several Forum recommendations provide solutions to this challenge (e.g. Action 2.4.2 - Extend the success of the Fish Water Management Tool to operations of Zosel Dam and include other sensitive aquatic species).

Fortunately, water management in the Okanagan has seen a surge in basic water science and tools over the past decade. Capitalizing on this science by increasing disciplinary integration and extending science products into practical decision support tools will support the multi-disciplinary cooperation necessary to find suitable compromises.

Greater flexibility is also critical to adjust to surprises, new knowledge and ongoing changes in climate. The renewed Orders should acknowledge the need for adaptive management and using the best science, tools, and knowledge to respond to environmental change.

5.0 SUMMARY OF RECOMMENDATIONS FROM 2011 FORUM

This report identifies forty-one (41) actions, almost half (20) of which are directed at the IJC for consideration in extending the scope of the renewed Operating Orders for Osoyoos Lake and Zosel Dam or the associated cooperative agreements (Table 5.1). As shown, Forum contributors have provided the IJC with a wide range of concrete and actionable recommendations on how to bring additional added value to the international Okanagan Basin. As not all of these actions are intended to be legally binding 'clauses' in the Orders, success of the IJC Osoyoos renewal process will be dictated by the degree to which these recommendations are adopted (informally or formally) and put into practice by the IJC and its future Board of Control members and other partners. The IJC is a natural coordinating leader and material supporter for many of the recommended actions. Forum participants made it clear that actions that are not formally written into terms of the renewed IJC Operating Orders themselves should be directed to other supporting agreements referenced by the future Board of Control and/or International Watershed Board and that the IJC should take a major role in coordinating development of these supporting flexible agreements.

Review of the IJC Plans of Study and OLWSF dialogue revealed recommendations that were reinforced by others and a few where there was disagreement or alternatives. We provide the following assessment of the degree of support for IJC Plan of Study / Forum recommendations as well as our knowledge of other relevant water science results in the Okanogan using the following guide:

	Evidence and support is **conclusive** with multiple IJC Plan of Study authors and Okanogan water science experts supporting this recommendation. Any residual disagreement over this recommendation would be readily outweighed by counter-evidence.
	The available evidence and rationale is sound and at least one other IJC Plan of Study author or Okanagan water science expert support this recommendation. However, the recommendation is not *definitive* in that there is a modest but detectable level of (informed) disagreement. Alternatively, this rating may be assigned if the recommendation is a lower priority relative to more conclusive recommendations.
	Available evidence thus far is not adequate to conclusively advise for/against this recommendation. Alternatively, counter recommendations exist amongst IJC Plan of Study authors or other scientific findings. In addition the recommendation hinges critically on value judgements/risk attitudes rather than scientific evidence. <u>This does not mean that the recommendation is "wrong"</u>, rather, there is a level of disagreement.

Future reviews of progress vs. the recommendations in Table 5.1 should also return to the 2007 Osoyoos Lake Water Science Forum actions that that were rated as having only fair or no progress (Figure 3.2).

Table 5.1: Summary of Recommendations from 2011 Osoyoos Water Science Forum and the IJC Plan of Study reports. Definitions for level of support symbols is provided above. Shaded cells indicate recommendations where the IJC / Board of Control have *at least* an indirect role in coordinating or fostering cooperation. Note: recommendations are **not** listed in any direct or implied priority sequence. Acronyms defined on page *vii*.

Reference Number	Recommendation	Who	Level of Support
CLIMATE VARIATION AND CHANGE			
2.1.1	Increase the number of weather stations operating in the Okanagan Basin.	Province of BC, Environment Canada (EC), local governments	
IJC-PS 6 Rec. 1	**If** the IJC deem it necessary to employ a drought declaration, allow droughts to be declared earlier in the spring. [See related IJC Studies 2&3 Rec. 1]	Board of Control on behalf of the IJC	
IJC-PS 6 Rec. 2[7]	Allow more flexibility in filling Osoyoos Lake.	Board of Control on behalf of the IJC	
IJC-PS 6 Rec. 3[7]	Allow gradual changes in lake level over a defined period as opposed to setting strict date-specific water level requirements.	Board of Control on behalf of the IJC	
IJC-PS 6 Rec. 4[7]	Reconsider whether a distinction between drought and non-drought conditions is required.	Board of Control on behalf of the IJC	
IJC-PS 6 Rec. 5	Evaluate the suitability of using fixed-dates for the summer and winter operating ranges in light of the projected future advance of the spring lake inflows.	Board of Control on behalf of the IJC	
IJC-PS 6 Rec. 6	Incorporate adaptive management principles and strategy to evaluate the performance of the revised Orders.	Board of Control on behalf of the IJC	
WATER QUANTITY			
2.2.1	Develop a basin wide drought plan.	Province of BC, local governments, OBWB (coordination)	
2.2.2	Improve water supply forecasting.	Province of BC, WSC, USGS, local governments	
2.2.3	Develop and fund additional demand management programs and (monetary) incentives for water saving technologies.	Province of BC, local governments	

[7] Other Studies also recommended this.

Reference Number	Recommendation	Who	Level of Support
			
IJC-PS 1 Rec. 1	Structure IJC Operating Orders for Zosel Dam to consider flows and lake elevation targets within a holistic system-wide water management frame. [See related: IJC Plan of Study 5 Rec. 1]	Board of Control on behalf of the IJC	
IJC-PS 1 Rec. 2	Better accommodate instream/fisheries flow criteria **in** the renewed Orders. [See related: IJC Plan of Study 5 Rec. 1]	Board of Control on behalf of the IJC	
IJC-PS 1 Rec. 3	During summer months in normal and drought years, manage Osoyoos Lake between 912 and 912.5 ft.	Board of Control on behalf of the IJC	
IJC-PS 1 Rec. 4	Improve research into alternative sources of water.	Board of Control on behalf of the IJC	
IJC Studies 2&3 Rec. 1	Eliminate the existing drought declaration and in the renewal Orders, follow a single, flexible management regime applied for both normal and drought years.	Board of Control on behalf of the IJC	
IJC Studies 2&3 Rec. 2	Incorporate ramping guidelines into future IJC Operating Plans for the Zosel Dam, namely downward ramping rates during periods of low flow between October 1 and March 1.	Board of Control on behalf of the IJC	
IJC Studies 2&3 Rec. 3	Use the Standardized Precipitation Index (SPI) to provide an indication of drought severity.	Board of Control on behalf of the IJC	
IJC-PS 7 Rec. 1	Increase coordination with operators of Okanagan Lake Dam at Penticton to improve control over high (and low) Osoyoos Lake levels.	Board of Control, BC MoE, Washington DoE	
IJC-PS 7 Rec. 2	Under normal water supply conditions maintain Osoyoos Lake water levels near the lower limit of the specified operating range (911.0 ft).	Board of Control, Washington DoE	
IJC-PS 8 Rec. 1	Continue monitoring Okanogan River downstream of Zosel Dam for sedimentation and other risks that may affect its ability to safely transmit flow.	Board of Control on behalf of the IJC	
WATER QUALITY			
2.3.1	Develop a bi-lateral aquatic vegetation and water quality management plan for Osoyoos Lake.	OBWB (coordination), IJC (coordination), Town of Osoyoos, City of Oroville, LOA, OLWQS, Washington DoE, Province of BC	
2.3.2	Explore the potential of a broader water quality index for Osoyoos Lake.	BC MoE, partners	

Reference Number	Recommendation	Who	Level of Support
			
2.3.3	Acquire additional land for wetland/riparian protection and continue wetland restoration projects, including constructed wetlands.	Public, NGO, private sector partnerships	
2.3.4	Continue to monitor estrogen concentrations in Okanagan River where dilution factors are lower (e.g. Okanagan River near Penticton).	UBC Okanagan researchers, BC MoE	
2.3.5	Conduct more extensive groundwater studies to fill knowledge gaps.	EC, UBC Okanagan, MoE	
2.3.6	Maintain collaborative partnerships with ONA, DFO, OLWQS, Washington DoE and others to determine status and trends in Osoyoos Lake relative to water quality objectives.	BC MoE, OLWQS, ONA, DFO, Washington DoE	
IJC-PS 4 Rec. 1	Focus on the continued study and control of nutrient loading to the lake rather than relying on changes in Zosel Dam operations.	Town of Osoyoos, City of Oroville, RDOS, RDCO, and related municipalities, BC MoE, Washington DoE	
IJC-PS 4 Rec. 2	Explore feasibility of lake oxygenation techniques.	Washington DoE, City of Oroville, partners	
IJC-PS 4 Rec. 3	Continue to refine conditions for, and monitoring of, flushing flow experiments and assess their effectiveness[8].	DFO, ONA, BC MoE	
FISHERIES AND SPECIES AT RISK			
2.4.1	Support programs that detect and control *new* invasive species such as walleye, zebra mussels and others.	BC MoE, Washington DoE, DFO, CCT, ONA	
2.4.2	Extend the success of the Fish Water Management Tool to operations of Zosel Dam and include other sensitive aquatic species.	COBTWG, Washington DoE, CCT, ONA	
2.4.3	Hold bi-annual State of the Watershed conferences.	Provincial, state, federal, First Nations, and local governments	
2.4.4	Continue to support and enhance resiliency as a key principal in restoration design.	All restoration practitioners	

[8] Evidence from opportunistic pulse flow releases from Okanagan Lake Dam down Okanagan River and into Osoyoos Lake have shown promise at mitigating temperature-oxygen squeeze in the north basin of the lake. The effectiveness of this technique depends on being able to release an adequate volume of water from Okanagan Lake Dam, as well as the strength of thermal stratification and bottom water anoxic conditions. Pulse flow releases are a helpful tool, but cannot be relied upon in all years to alleviate temperature-oxygen squeeze conditions in the north basin of Osoyoos Lake.

Reference Number	Recommendation	Who	Level of Support
			
IJC-PS 5 Rec. 1	Materially support and encourage Washington State, DFO, CCT, and ONA to agree on target ecological flows and risk thresholds associated with various flow rates in the Okanogan River below Zosel Dam. Strive to meet these fisheries demands.	IJC, Washington DoE, CCT, ONA, DFO	
IJC-PS 5 Rec. 2	Employ methods that sustain and improve suitable oxygen and temperature conditions in Osoyoos Lake.	Province of BC, COBTWG, Washington DoE, partners	
IJC-PS 5 Rec. 3	Invest in detailed habitat maps for threatened riparian and wetland species as well as related basic research on how riparian and wetland changes affect target species.	EC, Province of BC, Washington DoE, partners	
CONSERVATION AND GOVERNANCE			
2.5.1	Foster partnerships with Aboriginal peoples in Canada and the United States.	IJC, Government of Canada, federal US government, Columbia Basin First Nations in Canada and US	
2.5.2	Explore the implementation of an International Watersheds Initiative process for the Okanagan/Okanogan Basin.	IJC, Government of Canada, federal US government, OBWB	
LAND USE PLANNING			
2.6.1	Limit sprawl and regulate where development is happening and what kind of landscape people are using.	Local governments	
2.6.2	Develop and enforce responsible guidelines for different categories of on-lake recreational activity.	Town of Osoyoos, City of Oroville, provincial/state governments, 97 Okanagan Alliance	
2.6.3	Prepare Shoreline Management Guidelines for Osoyoos Lake based on the Foreshore Inventory Mapping and Aquatic Habitat Index.	Town of Osoyoos and partners	

6.0 HOW TO BE INVOLVED

6.1 List of Organizations Working on Projects Related to Osoyoos Lake

6.1.1 Not-for-profit groups

Osoyoos Lake Water Quality Society
www.olwqs.org
P.O. Box 1382, Osoyoos, BC V0H 1V0
Phone: 250-495-3134
Email: info@olwqs.org

BC Lake Stewardship Society
www.bclss.org
#203-1889 Springfield Rd, Kelowna, BC V1Y 5V5
Phone: 250-717-1212
Toll-free: 1-877-BCLAKES

Canadian Okanagan Basin Technical Working Group
www.obtwg.ca
Email: crivard@syilx.org
Link to newsletters:
http://www.obtwg.ca/newsletter.html

Osoyoos Oxbow Society Restoration Society
Contact Eike Scheffler
Phone: 250-495-7891

South Okanagan Similkameen Conservation Program
www.soscp.org
102 Industrial Ave, Penticton, BC V2A 7C8
Phone: 250-490-8225
Email: bryn.white@gov.bc.ca

Okanagan River Restoration Initiative
Contact: Steve Matthews, Fish and Wildlife Science and Allocation Section Penticton, BC Ministry of Forests, Lands and Natural Resource Operations
steve.matthews@gov.bc.ca

6.1.2 Agencies

International Joint Commission
www.ijc.org
Canadian Section Office:
234 Laurier Avenue West, 22nd Floor
Ottawa, ON K1P 6K6
Phone: 613-947-1420
Email: beckhoffb@ottawa.ijc.org
U.S. Section Office:
2000 L Street, NW, Suite #615
Washington, DC 20440
Phone: 202-736-9024
Email: bevacquaf@washington.ijc.org

Colville Tribes Fish & Wildlife Department
http://nrd.colvilletribes.com/
PO Box 150 Nespelem, WA 99155
Phone: 509-634-2200

BC Ministry of Environment Regional Operations Penticton
www.env.gov.bc.ca/okanagan/
102 Industrial Place
Penticton, BC V2A 7C8
Phone: 250-490-8200

Okanogan Conservation District
http://okanogancd.org/
1251 2nd Ave. South, Room 101
Okanogan, WA 98840
Phone: 509-422-0855, ext. 5
Email: ocd@okanogancd.org

Okanagan Nation Alliance Fisheries Department
www.syilx.org/naturalresources-fisheries.php
3255C Shannon Lake Road
West Kelowna, BC V4T 1V4
Phone: 250-707-0095

Washington State Department of Ecology
www.ecy.wa.gov
Contact: Alvin Josephy
Email: ajos461@ecy.wa.gov
300 Desmond Way
Olympia WA 98902
Phone: 360-407-6456

Environment Canada BC office
401 Burrard Street
Vancouver, BC V6C 3S5
Phone: 604-664-9100
Email: enviroinfo@ec.gc.ca

Agriculture and Agri-food Canada Pacific Agri-Food Research Centre
4200 Highway #97, South
Summerland, BC V0H 1Z0
Phone: 250-494-7711

6.1.3 Governments

Confederated Tribes of the Colville Reservation
www.colvilletribes.com
PO Box 150
Nespelem, WA 99155
Phone: 509-634-2200

Okanagan Nation Alliance
www.syilx.org
106-3500 Carrington Road
Westbank, BC V4T 3C1
Phone: 250-707-0095
Email: onareception@syilx.org

Town of Osoyoos
www.osoyoos.ca
8707 Main Street, Osoyoos BC, V0H 1V0
Phone: 250-495-6515

City of Oroville
www.orovillewashington.com
P.O. Box 2200, Oroville, WA 98844
Phone: 509-476-2926

Okanagan Basin Water Board
www.obwb.ca
1450 KLO Road, Kelowna, BC V1W 3Z4
Phone: 250-469-6271

Okanogan County Washington
PO Box 1010, Okanogan, WA 98840
Phone: 509-422-7125

Regional District of Central Okanagan
www.regionaldistrict.com
1450 KLO Road, Kelowna, BC V1W 3Z4
Phone: 250-763-4918

Regional District Okanagan-Similkameen
www.rdos.bc.ca
101 Martin St, Penticton, BC V2A 5J9
Phone: 250-492-0237
Toll free: 1-877-610-3737
E-mail: info@rdos.bc.ca

7.0 LITERATURE CITED AND FURTHER READING

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Barber, M, M. Beutel, W. Helander, B. Moore, C. H. Orr, L. Tran, and K. Rajagopalan. 2010b. IJC Plan of Study 4: Effects of Zosel Dam Water Regulation on Osoyoos Lake Water Quality. Report prepared for Washington State Department of Ecology.

Barber, M, M. Beutel, W. Helander, C. H. Orr, L. Tran, and K. Rajagopalan. 2010c. IJC Plan of Study 5: An Investigation of Methods for Including Ecosystem Requirements in Order of Approval. Report prepared for Washington State Department of Ecology.

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LGL Limited and Pacific Hydraulic Engineers and Scientists. 2009. Design of Flow Management Strategy and Mitigation Structures for the Okanogan River. Prepared for Colville Confederated Tribes, Omak, WA.

Okanagan Water Stewardship Council. 2008. Okanagan Sustainable Water Strategy: Action Plan 1.0. Prepared by the Okanagan Water Stewardship Council for the Okanagan Basin Water Board, Kelowna, BC. 104 pp.

Summit Environmental Consultants Inc. 2010. IJC Plan of Study 7 (Part 1): Demonstration of Factors that Govern Osoyoos Lake Levels During High Water Periods. Prepared for International Joint Commission, Ottawa Ontario. 47 pp.

Summit Environmental Consultants Ltd. 2010. IJC Plan of Study 8: Review of Methods to Monitor Channel Capacity of the Okanogan River Downstream of Osoyoos Lake – Part 1. Prepared for International Joint Commission, Ottawa Ontario. 34 pp. + Appendix.

Urban Systems. 2011. Evaluation of Criteria to Declare Drought (IJC Plan of Study 2) and Review of Dates for Summer & Winter Operation (IJC Plan of Study 3). Prepared by Urban Systems for the International Joint Commission International Osoyoos Lake Board of Control. 53 pp. + Appendices.

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APPENDIX A EMAIL ADDRESSES FOR PRESENTERS AND PANELLISTS

Clint Alexander, B.Sc., MRM
[*Forum Facilitator, 2007 and 2011*]
Managing Partner & Team Leader, ESSA Technologies Ltd.
calexander@essa.com

Karilyn Alex, M.S.
Fisheries Biologist, Okanagan Nation Alliance
klong@syilx.org

Phil Armstrong, B.A
Planning Technician, Town of Osoyoos
parmstrong@osoyoos.ca

MP Alex Atamamenko
Member of Parliament, BC Southern Interior
atamaa1@parl.gc.ca

Dr. Michael Barber, B.Sc., M.S.C.E., Ph.D.
Professor, Washington State University and Director, State of Washington Water Research Center
meb@wsu.edu

Dr. Cynthia (Cindi) Barton, PH.D., LHG, LG
Chair, U.S. Section, International Osoyoos Lake Board of Control and Director, U.S. Geological Survey, Washington Water Science Center
cbarton@usgs.gov

Dr. Marc Beutel, B.Sc., M.S., Ph.D.
Associate Professor, Civil and Environmental Engineering Department, Washington State University
mbeutel@wsu.edu

Chris Branch, B.Sc.
Community Development Director, City of Oroville
chrisb.oroville@nvinet.com

Irene B. Brooks, B.Sc.
Commissioner, U.S. Section International Joint Commission
brooksi@washington.ijc.org

Charles (Chuck) Brushwood
Policy Analyst, Colville Confederated Tribes
charles.brushwood@colvilletribes.com

Dave Caswell
Milfoil Control, Okanagan Basin Water Board
dave_caswell@hotmail.com

Mark Colosimo, Ph.D.
Engineering Advisor, U.S. Section International Joint Commission, U.S. Department of State
colosimom@washington.ijc.org

Jeff Curtis, Ph.D.
Head of Chemistry and Earth and Environmental Sciences, University of British Columbia Okanagan
Jeff.curtis@ubc.ca

Chris Fisher, B.S., M.S.
Fisheries Biologist, Colville Confederated Tribes
Chris.Fisher@colvilletribes.com

Sean Fleming
Senior Hydrogeologist for the Pacific and Yukon, Environment Canada
sean.fleming@ec.gc.ca

Brian Guy, Ph.D.
Senior Geoscientist, Summit Environmental Consultants
bg@summit-environmental.com

Dr. Kim D. Hyatt, Ph.D.
Research Scientist, Fisheries and Oceans Canada
Kim.Hyatt@dfo-mpo.gc.ca

John Janmaat, Ph.D.
Associate Professor of Economics, University of British Columbia Okanagan
john.janmaat@ubc.ca

Nelson R. Jatel, B.Sc.
Water Stewardship Coordinator, Okanagan Basin Water Board
nelson.jatel@obwb.ca

Vic Jensen, B.Sc., M.Sc.
Ministry of Environment
vic.jensen@gov.bc.ca

Kurt Kerns
President, Wetlands Pacific Corporation
dave@wetpac.com

Lyall D. Knott, Q.C.
Commissioner, International Joint Commission
LDK@cwilson.com

Michael T. Laitta
Geographic Information Systems Coordinator, International Joint Commission
laittam@Washington.IJC.org

Chief Clarence Louie
Chief, Osoyoos Indian Band
chief@oib.ca

James Mattison, PEng
Consultant, Urban Systems
js.mattison@telus.net

Tom McAuley
Senior Engineering Advisor, Canadian Section International Joint Commission
mcauleyt@ottawa.ijc.org

Richard Moy
Commissioner, U.S. Section International Joint Commission
moy@mt.gov

Senator Bob Morton
Senator, 7th Legislative District
Bob.Morton@leg.wa.gov

Denise Neilsen, Ph.D.
Research Scientist, Agriculture and Agri-Food Canada
denise.neilsen@agr.gc.ca

Craig Nelson
District Manager, Okanogan Conservation District
craign@okanogancd.org

Cailin Huyck Orr, Ph.D.
Assistant Professor, School of Earth and Environmental Sciences, University of Washington
chorr@wsu.edu

Jennifer Parsons, B.Sc., M.Sc.
Aquatic Plant Specialist, Washington Department of Ecology
jenp461@ecy.wa.gov

Joe Peone
Program Director of Fish and Wildlife, Colville Confederated Tribes
joe.peone@colvilletribes.com

Jason Schleppe, M.Sc., R.P.Bio
Principal, Ecoscape Environmental Consultants
jschleppe@ecoscapeltd.com

The Honourable Tom Siddon P.C., LL.D.
tsiddon@shaw.ca

MLA John Slater
MLA, Boundary-Similkameen
john.slater.mla@leg.bc.ca

Bryan Symonds
Director of Regional Operations, Water Stewardship Division, Ministry of Forest, Land and Natural Resources Operations
Brian.Symonds@gov.bc.ca

John Wagner, Ph.D.
Environmental Anthropologist, University of British Columbia Okanagan
john.wagner@ubc.ca

Anna Warwick Sears, Ph.D.
Executive Director, Okanagan Basin Water Board
anna.warwick.sears@obwb.ca

Ford Waterstrat
School Administrator, Seattle area
fs.waterstrat@gmail.com

Stu Wells
Mayor of Osoyoos
swells@osoyoos.ca

Howie Wright, M.Sc., R.P.Bio.
Senior Fisheries Biologist, Okanagan Nation Alliance
hwright@syilix.org

APPENDIX B 1982 ORDER OF APPROVAL FOR ZOSEL DAM

INTERNATIONAL JOINT COMMISSION

IN THE MATTER OF THE APPLICATION OF THE STATE OF WASHINGTON FOR APPROVAL TO CONSTRUCT A CONTROL STRUCTURE NEAR THE OUTLET OF OSOYOOS LAKE

ORDER OF APPROVAL

9 December 1982

Whereas Osoyoos Lake is stream flowing across the boundary within the meaning of Article IV of the Boundary Waters Treaty signed on 11 January 1909.

Whereas in accordance with the Treaty the State of Washington, hereinafter referred to as the Applicant, under date of 24 December 1980 submitted through the Secretary of State for the United States of America an application to the Commission for approval for the construction of works for regulating the levels of Osoyoos Lake in the Province of British Columbia and the State of Washington, the effect of which would raise the natural level of waters on the other side of the boundary, hereinafter referred to as the works.

Whereas pursuant to the said Treaty the Commission is to require, as a condition of its approval that suitable and adequate provision, approved by it, be made for the protection and indemnity of all interests on the other side of the boundary which may be injured thereby.

Whereas on 12 September 1946 the Commission in response to an application by the State of Washington issued an Order of Approval for Zosel Dam subject to several conditions which included alterations that would provide a capacity of 2500 cubic feet per second when its forebay elevation is 9ll.0 United States Coast and Geodetic Survey (USCGS) and Zosel Dam is now unable to meet that requirement.

Whereas the proposed works are intended to replace Zosel Dam, a timber structure originally built in 1927, repaired from time to time, but now in a deteriorated condition and overstressed when the water level immediately upstream from Zosel Dam is at elevation 911 USCGS.

Whereas the United States Coast and Geodetic Survey (USCGS) datum for Osoyoos Lake levels gives readings 0.26 feet greater than the Geodetic Survey of Canada (GSC) datum. For example, elevation 911.0 USCGS equals elevation 910.7 GSC.

Whereas submitted with the application was a cooperation plan entitled “British Columbia Washington State Cooperation Plan for Osoyoos Lake Levels and TransBorder Flows”, prepared by the Department of Ecology of the State of Washington and the Ministry of Environment of the Government of British Columbia, the implementation of which depends upon the physical capability of the proposed works.

Whereas notices that the application had been filed were published in accordance with the Rules of Procedure of the Commission.

Whereas Statements in Response were received by the Commission and the Applicant filed a Statement in Reply with the Commission. Copies of the Statements in Response and the Statement in Reply are on file and available for examination at the offices of the Commission in Ottawa and Washington.

Whereas pursuant to published notices public hearings were held at Oroville, Washington on the morning of 8 December 1981 and at Osoyoos, British Columbia on the afternoon of the same day, at which all persons attending and interested were afforded opportunity of presenting, under oath, evidence to the Commission. Copies of the transcript of the public hearings are on file and available for examination at the offices of the Commission in Washington and Ottawa.

Whereas the spokesman for the Applicant stated that failure of Zosel Dam to maintain established lake level" would result in appreciable damage "and financial loss to agriculture, recreational and municipal interests on both sides of the International Boundary; that the cooperation plan provides for emergency storage in Osoyoos Lake during watershort years; that this emergency storage would be used for fisheries protection, domestic use and irrigation in both countries; and that the Applicant and the Province of British Columbia, hereinafter called the Province, "are now working together to develop suitable financial arrangements for funding the proposed works.

Whereas the spokesman for the Province stated that the Province endorsed the application; that the Province does not consider the cooperation plan to be part of the application; and that the cooperation plan does not guarantee any transboundary flow but outlines procedures and flows which will be satisfied as far as practicable.

Whereas during a period of drought the natural inflow to Osoyoos Lake is near zero in the latter pert of the summer and the evaporation from Osoyoos Lake for July and August may exceed 12 inches, that the minimum level for the satisfactory operation of pumps in British Columbia supplying water from Osoyoos Lake for irrigation is 910.3 USCGS, and that future periods of drought will require careful management of releases of stored water.

Whereas the Commission heard expressed and shared the concern that if the flows provided for in the cooperation plan were given effect, then such flows could jeopardize the maintenance of Osoyoos Lake levels designed to protect and indemnify interests generally, and more particularly, applicants for new water licenses.

Whereas the Commission's consideration of the present Application in no way affects the right of the upstream country as set out in Article II of the Boundary Waters Treaty of January 11, 1909 to construct, maintain and operate such works as it may consider necessary or desirable for the purpose of making the most advantageous and reasonably practicable use on its own side of the International Boundary by diversion of the upstream waters as regulated by headwater storage reservoirs lying entirely within the upstream country and constructed wholly at the expense of the upstream country or at the expense of the upstream country's interests.

Whereas the spokesmen for the Applicant and the Province stated that notwithstanding the relationship of the cooperation plan to the proposed works, it is their view that the Cooperation Plan does not create an enforceable obligation to provide or any enforceable right to receive transboundary flows, but rather constitutes an expression of intention to satisfy the objectives therein, consistent with satisfaction of water needs as they arise in British Columbia, and so far as may be practicable while maintaining lake levels provided for in this Order.

Whereas several witnesses testified that a maximum Osoyoos Lake level of 912.5 feet USCGS was preferred to elevation 913.0 feet as requested in the application.

Whereas hydrological analyses indicate that the level of Osoyoos Lake has, and probably will again, exceed elevation 913.0 USCGS at least every other year and for a duration varying from two days to two months, that the probable recurrence interval of the lake level exceeding elevation 915.0 is 12 years and that in 1972 Osoyoos Lake level peaked at elevation 917.1 feet USCGS.

Whereas flood flows of the Similkameen River create a backwater in the Okanogan River at Oroville thereby reducing the outflows from Osoyoos Lake, raise the water level of Osoyoos Lake above that which would have occurred in the absence of a backwater and in some years causes the Okanogan River to reverse its direction and flow north into Osoyoos Lake.

Whereas Tonasket Creek during freshets frequently carries a large bedload of sand, gravel and boulders which are deposited in the Okanogan River channel about a mile below the outlet of Osoyoos Lake forming a natural obstruction which reduces the capacity of the Okanogan River channel and this natural obstruction has been removed a number of times only to form again.

Whereas detailed analysis of recorded water levels of Osoyoos Lake from 1948 to 1981 inclusive indicates that for the period 1 April to 31 October in those years the levels have been 911.0 USCGS or above 82 percent of the time, 911.5 USCGS or above 50 percent of the time, 912.5 USCGS or above 11 percent of the time, and 913.0 USCGS or above 6 percent of the time. Moreover, the level of Osoyoos Lake has been maintained between elevation 911.0 and 911.5 USCGS 32 percent of the time.

Whereas the Commission on April 28, 1982 issued an Order of Approval for the works described herein; the Applicant by letters dated July 8 and November 30, 1982, and the Province of British Columbia by letters dated July 29 and December 2, 1982, submitted comments with respect to the said Order; the Commission, having concluded that none of the items raised in those letters involved issues of substance not raised at the public hearings, has reconsidered the wording of the April 2B, 1982 Order and has issued this Order of Approval.

The Commission concludes that there is an urgent need to replace Zosel Dam, that the works would facilitate control of the water levels of Osoyoos Lake for the benefit of agriculture, tourism and other interests, and that the works would not create flood levels any more extreme than would have occurred if Zosel Dam had remained in place and been maintained and operated in accordance with the 1946 Order of Approval.

The Commission concludes further that if the works are constructed, operated and maintained in accordance with the conditions and other provisions of this Order, suitable and adequate provision will have been made for the protection and indemnity of all interests in Canada that may be affected thereby.

NOW THEREFORE THIS COMMISSION ORDERS AND DIRECTS that the construction, maintenance and operation, by the applicant, of a control structure and related works, herein called the works, on the Okanogan River downstream from the outlet of Osoyoos Lake be and the same are hereby approved, subject to the following conditions:

1. The control structure shall be located on the Okanogan River, approximately 300 feet downstream from the Cherry Street Bridge in Oroville, Washington, and upstream from the existing Zosel Dam, as shown in the concept plan submitted by the Applicant.

2. The principal works shall include a reinforced concrete control structure with appropriate power operated control gates, piers having adequate capability for breaking ice, a stilling basin, fish passage facilities, compacted earth embankments on each flank of the structure, the relocation of Tonasket Creek, and necessary dredging in the Okanogan River.

3. The top of the piers and sidewalls shall not be lower than elevation 917.5 feet United States Coast and Geodetic Survey (USCGS) datum. Wing walls and training walls may be at a lower elevation. The control gates shall be of sufficient number and size so as to have a capacity of at least 2500 cubic feet per second when the elevation of Osoyoos Lake is 913.0 feet USCGS and there is no appreciable backwater effect from the Similkameen River.

4. Tonasket Creek shall be relocated so that its confluence with the Okanogan River is at the oxbow immediately upstream from Zosel Dam, as shown on the concept plan submitted by the Applicant. The channel of the Okanogan River between the control structure and the location of Zosel Dam shall be dredged whenever necessary so as to ensure that it has the same capacity as the control structure when the elevation of Osoyoos Lake is at 913.0 feet USCGS.

5. Before commencing construction of the said works, the Applicant shall deliver to the Commission four copies of the necessary permits, approvals and certifications from the Washington State Departments of Ecology, Fisheries, and Game as well as Okanogan County and the United States Army Corps of Engineers.

6. During construction of the said works, the Applicant shall operate all available facilities and carry out construction so as to maintain levels as nearly as possible in conformance with those prescribed in Conditions 7, 8, 9 and 10.

7. Upon completion of construction the Applicant, in consultation with the Board of Control appointed under Condition 14, shall operate the works so as to maintain the levels of Osoyoos Lake between elevation 911.0 and 911.5 feet USCGS to the extent possible from 1 April to 31 October each year except under drought conditions in the Okanogan Valley (in Canada Okanagan Valley), as defined in Condition 8 and also during the appreciable backwater conditions and excessive inflows described in Condition 9. Furthermore, the Applicant shall operate the works so as to maintain the levels of Osoyoos Lake between elevation 909.0 and 911.5 feet USCGS from 1 November to 31 March each year.

8. During a year of drought as determined by the Board of Control accordance with the criteria set forth below, the levels of Osoyoos Lake may be raised to 913.0 feet USCGS and may be drawn down to 910.5 feet USCGS during the period 1 April to 31 October. The criteria are:

> (a) the volume of flow in the Similkameen River at Nighthawk, Washington for the period April through July as calculated or forecasted by United States authorities is less than 1.0 million acrefeet or
>
> (b) the net inflow to Okanagan Lake for the period April through July as calculated or forecasted by Canadian authorities is less than 195,000 acrefeet or

(c) the level of Okanagan Lake fails to or is forecasted by Canadian authorities to fail to reach during June or July elevation 1122.8 feet Canadian Geodetic Survey Datum.

Drought year operations shall be terminated when in the opinion of the Board of Control none of the three criteria defining a drought year exist. The level of Osoyoos Lake shall then be maintained in accordance with Condition 7.

9. During appreciable backwater conditions caused by flows in the Similkameen River, particularly during the freshet period, and during abnormal excessive flows in the Okanagan River, the works shall be operated so as to maintain the level of Osoyoos Lake as near as possible to the elevations prescribed in Conditions 7 and 8 herein. In such an event every effort shall be made to lower the level of Osoyoos Lake in the shortest practicable time.

10. In the event of circumstances including but not restricted to a prolonged drought coupled with high evaporation from Osoyoos Lake, activities to destroy milfoil, or underwater construction, the Commission upon written advice and recommendation from the Board of Control may allow a temporary deviation from the levels prescribed in Conditions 7 and 8.

11. In the event of water supplies in excess of the recorded supplies the said works shall be operated to provide levels on Osoyoos Lake no more extreme than would have occurred had the works not been built and had Zosel Dam remained in place and maintained and operated in accordance with the 1946 Order of Approval.

12. Upon completion of the works the existing Zosel Dam shall be completely removed so that it is no longer an obstruction in the Okanogan River.

13. All levels of Osoyoos Lake shall be defined as those measured at the International Gauging Station known as "Osoyoos Lake near Oroville" and shall be expressed in terms of USCGS datum.

14. The Commission shall appoint a Board of Control to be known as the International Osoyoos Lake Board of Control with an equal number of members from each country to ensure compliance with the provisions of this Order including operation and maintenance. The Board shall keep the Commission currently informed of all matters relating to this Order including the occurrence and termination of drought conditions and report promptly any violation of this Order to the Commission and compliance by the Applicant with any instructions of the Commission as may be issued from time to time with respect to this Order. The Board shall submit reports to the Commission at such times as the Commission may determine. These reports shall include all hydrological, operational, maintenance information and diversions from Osoyoos Lake as may be required. In the event of a disagreement amongst the members of said Board of Control which they are unable to resolve, the matter shall be referred by them to the Commission for decision.

15. The Applicant shall maintain the works in a manner satisfactory to the Board of Control.

16. During the period April 1 to October 31 each year, the Applicant shall maintain the level of Osoyoos Lake at or above elevation 910.5 feet USCGS to the extent possible through the regulation of outflow and the adherence to the terms of the "Report of Findings of Fact and Decision" approved by the State of Washington on October l9, 1981 pertinent to the State of Washington's decision on the water right application for change in point of diversion and place of use by the Oroville-Tonasket Irrigation District. In this regard also, the Applicant shall require that all future licenses issued subsequent to the date of this Order and for the diversion of water upstream from the control

structure contain the condition that the diversion be terminated when the elevation Osoyoos Lake drops below elevation 910.5 feet USCGS.

17. The Applicant shall be responsible for the disposition of claims for physical injury or damage to persons or property occurring in Canada in connection with the construction, maintenance and operation of the works and for the satisfaction of any such claims that are valid.

And it is further ordered that the Commission retains jurisdiction over the subject matter of this application and after giving such notice and opportunity to all interested parties to make representations as the Commission deems appropriate may make further order or orders relating thereto as may be necessary in judgment of the Commission.

This approval will terminate:

(a) ninety (90) days after the date of signing of this Order unless within that time the Applicant informs the Commission in writing that it accepts all of the conditions set forth herein;

(b) three years after the date of signing, unless before that date the control structure and appurtenant works are essentially complete and operational according to the provisions of this Order;

(c) twenty-five (25) years after completion of construction, unless renewed.

Signed this 9th day of December, 1982
E. R. Olson
R. C. McEwen
C.M. Bedard
L. K. Bulen
D. L. Totten